DESIGN edition
SEPTEMBER 1, 1958
Price 50 cents
Product Engineering
McGRAW-HILL MAGAZINE OF DESIGN
RESEARCH AND DEVELOPMENT
Trackless loader and
shuttle car
mine copper ores—page 5
2
ENGINEERING IN EUROPE

Dryer section of Rice Barton paper making machine installed at Crane and Co., Dalton, Mass. This is one of three similar Rice Barton dryer sections which have given trouble-free service at this company since the initial installation in 1955.

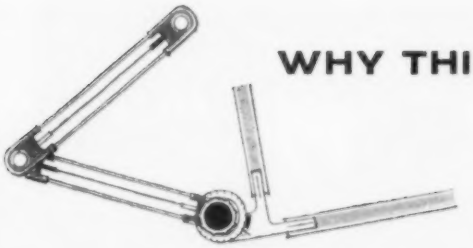
With CLEVELAND worm gear drives, this dryer offers 5 outstanding advantages

HERE are the big advantages for his paper dryer which this builder sees in using Cleveland Worm Gear Drives:

1. The back side of the dryer is opened up so that the same ventilating characteristics are present on both the tending side and driving side.
2. Load pulsations are self-contained and not transmitted from dryer to dryer.
3. Broke can be removed with equal ease from either side of the machine.
4. The drive is very smooth and very quiet.
5. Due to the absence of large open gear trains, the machine can be operated safely from the driving side as well as from the tending side.

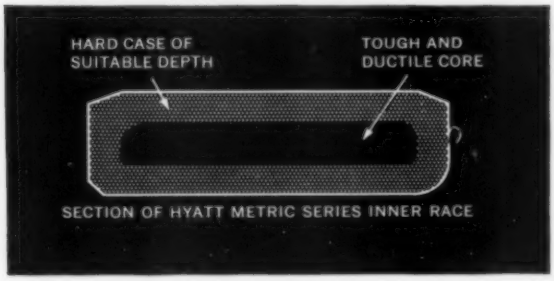
Why not learn how these and other advantages can be added to your machines through use of Cleveland Worm Gear Drives? Write for Catalog 400. The Cleveland Worm and Gear Co., 3279 E. 80th St., Cleveland 4, O.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers, Limited.

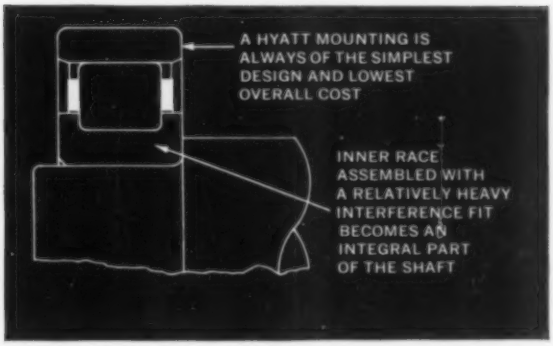


WHY THINGS RUN SMOOTHER WHEN YOU SPECIFY HYATTS

1. CARBURIZING PERMITS HEAVIER INTERFERENCE FITS



2. HEAVIER FITS SIMPLIFY MOUNTING, REDUCE COSTS


A HYATT MOUNTING IS ALWAYS OF THE SIMPLEST DESIGN AND LOWEST OVERALL COST
INNER RACE ASSEMBLED WITH A RELATIVELY HEAVY INTERFERENCE FIT BECOMES AN INTEGRAL PART OF THE SHAFT

HYATT PIONEERED THE USE OF CARBURIZING TYPE ALLOYS IN ORDER TO OBTAIN THE ADVANTAGES OF HEAVIER RACE FITS

To obtain the best possible performance, roller bearing races must be assembled on shafts and in housings with fits developed by design and experience. The most frequent condition to be met is a rotating shaft where specific load and speed conditions must be satisfied with appropriate race fits. These vary according to the manufacturer, and in the case of some manufacturers, according to the application. Naturally, the fits will also vary according to bearing type and size. How HYATT achieves the optimum in heavier race fits is detailed at right.

You will find full selection and application data in HYATT Catalog 150, or call your nearest HYATT Sales Engineer. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.; Pittsburgh; Detroit; Chicago; and Oakland, Cal.

1 With the standard metric series of cylindrical roller bearings there is a choice of two fitting practices: (1) Inner races of through-hardening steel, which dictates fairly light interference fits to avoid splitting. (2) Inner races of low carbon steel carburized and hardened to develop a suitable surface hardness and a tough ductile core. The latter permits much heavier interference fits and eliminates holding devices, because the race becomes practically an integral part of the shaft.

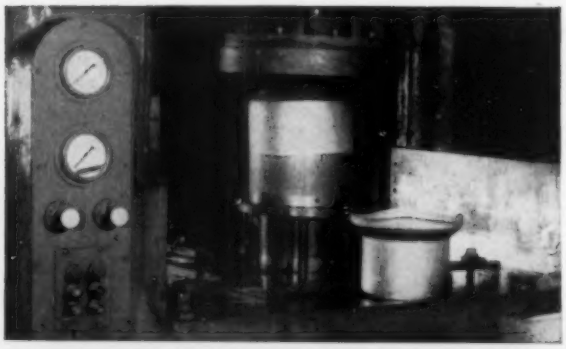
2 HYATT originated the carburized race and relatively heavy inner race fits to simplify bearing mounting and eliminate retaining devices. Practically all HYATT inner races are made from nickel alloys of the carburizing type. They permit the simplest kind of mountings and lowest overall cost, and their shoulders will withstand considerably greater impact loads than those of through-hardened races.

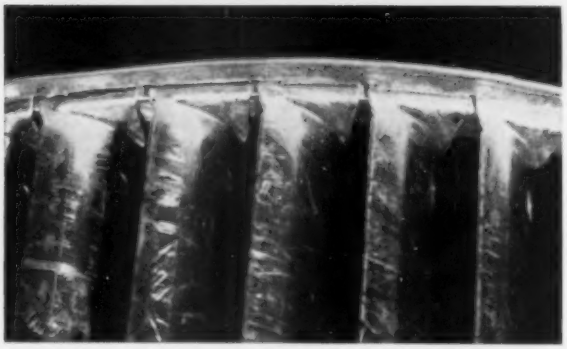
THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

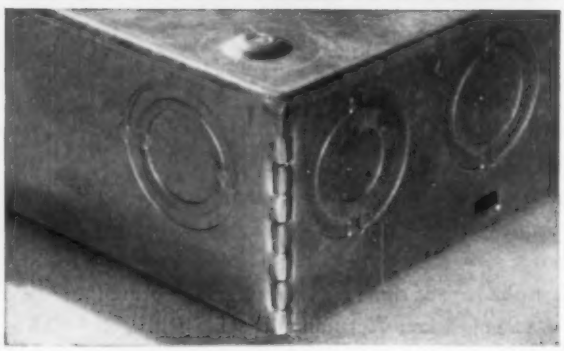
1908–1958

HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

Draw, Form, Interlock or Pierce Armco ZINCGRIP Steel– Its Special Zinc coating stays on







Workable zinc-coated Armco steel offers opportunities to cut production costs, add sales points to your products.

More than 22 years' experience in metalworking shops has proved that Armco ZINCGRIP® can be worked to the limits of the base metal without flaking or peeling of the special hot-dip zinc coating.

Cuts Production Costs

The ductile, adherent coating on ZINCGRIP means you don't have to baby it in the shop. In sheets or coils, it can be fabricated readily on modern high speed production equipment. And mill-coated ZINCGRIP often makes it possible to eliminate costly painting or plating operations on parts that must be protected from rust.

Adds Sales Points

Besides cutting costs, products made of ZINCGRIP have a smooth, attractive appearance that gives them sales appeal and economical corrosion resistance that keeps customers satisfied.

Let us send you more information on how the multiple advantages of Armco ZINCGRIP Steel can help you give your products an edge on competition. Just fill out and mail the coupon.

ARMCO STEEL CORPORATION. 7348 Curtis St., Middletown, Ohio

Send me information on Armco ZINCGRIP Steel We manufacture_____

New steels are born at Armco

NAME _____

COMPANY _____

STREET _____

CITY ZONE STATE

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

SEPTEMBER 1, 1958 Vol. 29, No. 35

Engineering in Europe—a Quick Look 32... E. J. Tangerman, Editor
You've already read our chief editor's eye-opening, eyewitness evaluation of Soviet progress in his article, "How Moscow Designs." Now we present what Tangerman uncovered on the rest of his recent European swing—in visits and shoptalk with engineers in London, Hannover, Zurich, Baden, Milan, Turin and Stockholm.

Engineering Design—More Than Glamor 38... Hugh Clausen, Lord Westwood Memorial Lecturer
Satellite and missile failures are caused by poor design, not inadequate science—a reminder that all civilization will lose if young engineering graduates are permitted to bypass the drawing board in their rush for "success."

Design Features in New Products 40... This tape recorder rides planes; second flywheel gives double-duty press; cast rotor simplifies generator; light catches glassware defects.

For Better Phenolic Molded Parts 44... D. M. Buchanan, Bakelite Co
Knowing the ground rules is vital because this thermosetting plastic doesn't allow a second guess—it must be molded correctly the first time. This article will be your guide.

DESIGN FILE

14 Indexing Devices 48... Federico Strasser, Mankowitz & Strasser, Ltd
How to get accurate positioning of their moving parts.

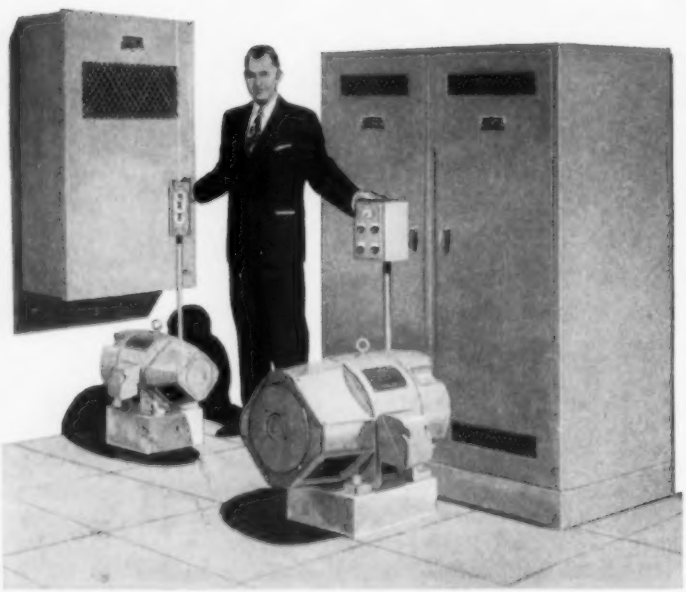
Stresses in Press-fit Bushings 51... E. H. Schuette, Dow Chemical Co
Here is a family of formulas, each helpful for calculating stresses in a typical application.

Interesting to Note	5	**Editorial**	31
Developments to Watch	19	**New Components, Materials**	55
The Engineering Week	21	**Catalogs and Bulletins**	72
Reader to Editor	26	**Design Abstracts**	76
Design Perspectives	29		

Cutler-Hammer presents ULTRAFLEX the spectacular STATIC POWER Adjustable Speed Packaged Drives

NO MOVING PARTS!

Cutler-Hammer Ultraflex Packaged Drives provide outstanding savings in installation, operation, and maintenance



ULTRAFLEX • *E* 25 hp ULTRAFLEX • *M* 100 hp

CUTLER-HAMMER CONTROL C-H

Ultraflex Packaged Drives offer new opportunities for quick, cost-cutting installations. Light, compact static power conversion components have replaced the conventional m-g set resulting in substantial savings in size and weight. Ultraflex Packaged Drives save up to 50% in valuable floor area . . . up to 75% in weight. Ultraflex units require no balancing or alignment attention during installation.

Ultraflex Packaged Drives provide a new high standard of operational efficiency and ultra-responsive speed control. Exclusive Ultraflex static power conversion systems guarantee greater efficiency than ever possible with conventional drives. Every Ultraflex Packaged Drive works perfectly without forced ventilation which means less power is consumed as unwanted heat. Also, Ultraflex Packaged Drives are noise and vibration free.

Dependable, maintenance-free performance is one of the most outstanding achievements of the all new Cutler-Hammer Ultraflex Packaged Drives. With Ultraflex Static Power Conversion Systems there are no bearings to lubricate. There are no commutators to service, no brushes to replace. There are no shafts to align, no couplings to maintain, no inertia loads to balance. There are no ventilation fans, no filters to clean or change.

Cutler-Hammer Ultraflex Packaged Drives are available in two forms . . . Ultraflex E—the 1 to 40 hp, low cost electronic type adjustable speed drive and Ultraflex M—the 1 to 200 hp, ultra-efficient magnetic amplifier type adjustable speed drive. Both forms come complete with the Ultraflex control unit, heavy-duty D-c drive motor and operator's control station. For detailed information, write today on your company letterhead for the new Ultraflex E Bulletin EN64-S249 or the new Ultraflex M Bulletin EN65-S249. CUTLER-HAMMER Inc., Milwaukee 1, Wis.

ALBERT HAUPTLI *publisher*

ELMER J TANGERMAN *editor*
ROBERT W CARSON *managing editor*

PAUL N ANDERSON *associate editor*
ROBERT E ABBOTT *associate editor*
JOHN KOLB *associate editor*
NICHOLAS CHIRONIS *associate editor*
RICHARD M KOFF *associate editor*
FORD R PARK *associate editor*
ROBERT S PRENTISS *associate editor*
ANNESTA R GARDNER *associate editor*
WILLIAM GILMAN *associate editor*
FRANKLIN D YEAPLE *associate editor*
JOSEPH J KELLEHER *associate editor*

BENEDICT A LEERBURGER, JR *assistant editor*
DOUGLAS C GREENWOOD *assistant editor*
PHYLLIS B SWEED *assistant editor*
DORA K MERRIS *assistant editor*
HERBERT KEE *assistant editor*
CHARLES J LYNCH *assistant editor*

FELIX GIORDANO *Detroit*
JACK MEYER *Los Angeles*
SETH PAYNE *Washington*

RICHARD E ROOMAN *art director*
E G LOADER *assistant art director*
ANGELA M GIACIN *assistant*

NORMA J VAN NESS *production supervisor*
LILLIAN M WITHAM *assistant*

JOSEPH KERR *consulting editor*
ROBERT E BRUCKNER *consulting editor*

DEXTER KEEZER *director, economics dept*
GEORGE B BRYANT, JR *Washington*
DONALD MacDONALD *Detroit*
WILLIAM G MELDRUM *Cleveland*
STEWART W RAMSEY *Chicago*
MARGARET RALSTON *San Francisco*
JOHN H KEARNEY *Los Angeles*
MICHAEL J MURPHY *Los Angeles*
RAY BLOOMBERG *Seattle*
CHARLES T DIXON, JR *Atlanta*
KEMP ANDERSON, JR *Dallas*
JOHN WILHELM *editor, world news*
JOHN TUNSTALL *London*
JOHN SHINN *London*
GENE DI RAIMONDO *Milan*
RAYMOND SHAH *Zurich*
ONNIC M MARASHIAN *Beirut*
PETER WEAVER *Mexico City*
JOHN PEARSON *Caracas*
SILKE BRUECKLER *Bonn*
SIDNEY MORRISON *Bonn*
SOL SANDERS *Tokyo*

STANLEY J ALLING *associate publisher*
PHILIP G WEATHERBY *advertising sales manager*
P F PRITCHARD *manager, market research*
ROBERT C MATTOON *circulation manager*
C C KANE *reader service manager*
RUSSELL T DOUGLAS *business manager*

Interesting to Note . . .

Copper Mine

With the advent of copper, the Bronze Age slowly replaced the era of stone. Peoples in North Africa traded with nations across the Mediterranean. Soon copper became not only a material for products like nails, shields, and precious ornaments but a medium of exchange among peoples and nations. Still in existence are nails and spikes from Roman ships sunk in Lake Nemi, Italy, over a thousand years ago. A 5500-year-old copper pipe, once used to convey water to an Egyptian Pharaoh's swimming pool, was recently found in one of the Pyramids. The pipe could still carry water.

The most impressive use of copper, formed into bronze, was the casting of the giant statue of Helios. Straddling the entrance to the Greek harbor of Rhodes, the statue stood about 105 ft tall. Ships, with sails fully unfurled, could sail between its legs with no difficulty. Beacon lights in each of its upstretched hands guided ships to port at night. In 224 BC, an earthquake destroyed this Colossus of Rhodes as well as most of the town.

Although the world's copper centers are no longer only in Africa, our cover shows operations in the Mufulira Copper mines, Ltd, Rhodesia. Two new American machines, a Joy shuttle car and an Eimco 630 loader, are teamed together in drift and tunnel work inside the Rhodesian mine. Impressed by the success of this color photo taken under adverse conditions, we are printing this picture sideways–the only way it can be. This violates our preference for cover pictures printed vertically–but we trust readers won't object.

16th Century Laboratory

Our chief editor, E. J. Tangerman, spent several weeks in England, Germany, Switzerland, Italy and Sweden principally to contact our field editors there. He did, however, also visit a number of plants and talk with engineers in each country. His impressions of this European swing are described on p. 32. Although most European laboratories are characterized by their casual make-do appearance they are markedly different from the laboratories Tangerman would have found in Europe had he made the trip 300 years ago.

Because the scientist of 1658 was primarily an alchemist, his laboratory would contain a multitude of phials, beakers and jars of assorted sizes–many filled with acids and reagents; some contain-

(Continued on page 7)

Product Engineering
A McGRAW-HILL PUBLICATION

SEPTEMBER 1, 1958 Vol. 29, No. 35

PRODUCT ENGINEERING is published weekly, with an additional Design Digest Issue in Mid-September, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. PUBLICATION OFFICE, 99-129 North Broadway, Albany 1, N. Y. See panel right for directions regarding subscription or change in address.
EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W. 42nd St., New York 36, N. Y.

Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice-President; L. Keith Goodrich, Vice-President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President. Publication Division: Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; A. R. Venezian, Vice-President and Circulation Coordinator.

Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Position and company connection must be indicated on subscription orders. Send to address shown in box at right.

United States subscription rate for individuals in the field of the publication, $5.00 per year, single copies fifty cents. Canadian subscription $7 per year; foreign $25 per year, payable in advance. Second-class privileges authorized at Albany, N. Y. U.S.A. © Copyrighted 1958, McGraw-Hill Publishing Company, Inc., all rights reserved.

PRODUCT ENGINEERING articles are indexed in both the Industrial Arts Index and the Engineering Index. PRODUCT ENGINEERING publishes its own semi-annual index including the Design Digest Issue. Copies are obtainable on request to the Editor.

SUBSCRIPTION. Send subscription correspondence and change of address to Fulfillment Manager, PRODUCT ENGINEERING, 330 W. 42nd St., New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address, and including postal zone number, if any. If possible, enclose an address label from a recent issue of the magazine. Since copies are addressed one to two issues in advance, please allow one month for change of address to become effective.

Postmaster: Please send form 3579 to PRODUCT ENGINEERING, 330 W. 42nd St., New York 36.

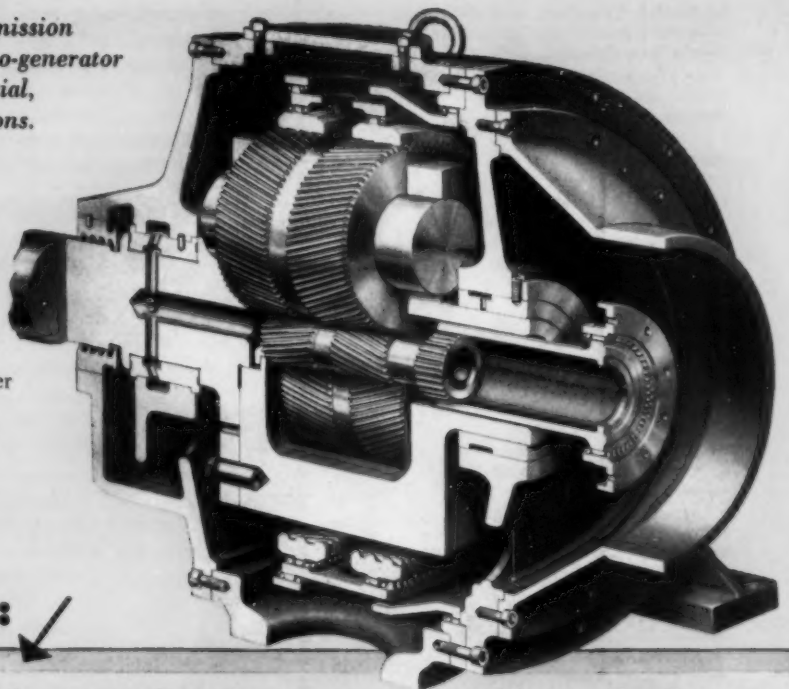
DE LAVAL-STOECKICHT
PLANETARY GEAR

...for high speeds...high horsepower

Proved in hundreds of installations abroad totalling over 3,000,000 horsepower—now available in America!

For all high torque power transmission applications such as pump turbo-generator and compressor drives in industrial, municipal and marine installations.

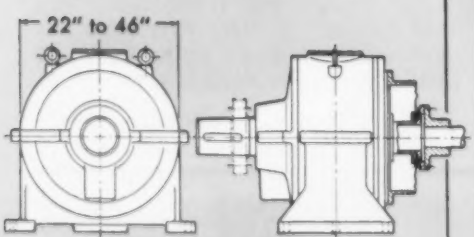
This cutaway view of the De Laval-Stoeckicht Planetary Gear shows how it provides flexibility for proper load distribution throughout the gear members. The thoroughly proved and tested design is completely reliable in transmitting high horsepower for high speed applications. • Highest efficiencies (98% or higher)... no high speed bearings... less friction losses.



Check These Advantages:

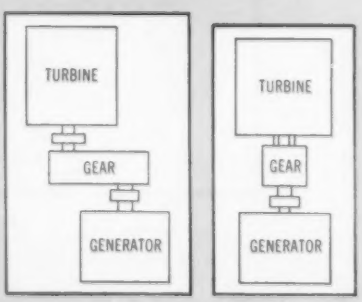
Small Size—Light Weight

Compact—low weight per hp. Sizes range from 22" to 46" in diameter, depending on horsepower requirements. Example: 5000 hp planetary unit weighs 1700 lbs. against 6000 lbs. for conventional gear.



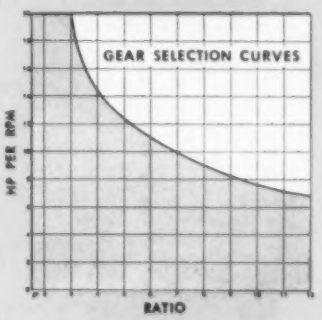
Convenient Arrangement

Co-axial or "in-line" arrangement of gear members takes up far less space than parallel axis gears of equivalent horsepower rating.



Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.



For further details, write for Bulletin 2400.

DE LAVAL *Steam Turbine Company*

Nottingham Way, Trenton 2, New Jersey

491

Interesting to Note . . . . *(continued)*

ing live lizards, snakes and leeches. On the wall, our editor would have been impressed with the variety of stuffed animals and fishes. The fish was an early symbol of Christ. Some skeletons of man and beast would be seen in the corner and anatomy charts would be scattered about haphazardly. Hanging from the ceiling would be a stuffed crocodile. The crocodile apparently would cure just about anything–its blood was for snakebite and eye diseases; the flesh, eaten or applied to a wound, would relieve symptoms; powdered skin went into an open sore; a rubdown with crocodile fat would reduce fever; for toothaches one carried a crocodile's tooth around the neck.

The Musket Man

While France was in the closing hours of its Revolution (1787-1799), the American government realized the importance of strengthening its own forces as soon as possible. Congress debated the issue and quickly agreed to appropriate funds for the purchase of arms. On May 1, 1798, Oliver Wolcott, Secretary of the Treasury, received a letter from a 32-year-old dreamer named Eli Whitney. In part, Whitney wrote, ". . . I ask the privilege of having an opportunity of contracting for the supply of the articles which the US may want. I should like to undertake to manufacture ten or fifteen thousand stands of arms. . ."

Such a proposal in 1798 was preposterous. To build one musket meant a gunsmith's working on the piece until it was finished. One good firearm might take several weeks to build. Even more preposterous was the fact that the government awarded Whitney the contract within six weeks after receiving his apparently insane proposal.

For the first time in America, a product was to be mass-produced by automatic machinery working on an assembly-line basis. Existing parts were not uniform so Whitney had to establish his own standards. An entire shop had to be equipped with machines not yet designed. But within two years Whitney began turning out muskets at $13.40 each. When some skeptical Congressmen still doubted his revolutionary production methods, Whitney threw a pile of parts on a table and started assembling. Soon the Congressmen saw the unbelievable come to pass. The parts grew into exactly 10 muskets–not one part missing, not one left over.

Whitney was more than just an engineer or a machine designer. His cotton gin gave him his reputation. Yet constant patent infringements caused him disillusionment and economic chaos. He moved to New Haven, Conn., where he devised the plan for mass production which he incorporated in his musket program. With his own design philosophy (p. 38) he laid the groundwork followed a century later when R. E. Olds introduced the "Oldsmobile." Within three years the revolutionary design concept of interchangeable parts enabled Olds to produce 4000 cars a year. Ten years later, Henry Ford followed the Whitney plan and the rest has been written in the history books of America.

Thaddeus Lowe and His High Balloon

With satellites spinning above the earth, sending back messages about cosmic radiation, temperature and meteor bombardment, it's sometimes hard to realize that less than a century ago history was made by another type of aerial sphere–the balloon. In 1862, the Civil War was in its second bloody year when a scientist named Thaddeus Lowe suggested this unique method of reconnaissance to the War Department. His idea, weird as it sounded, was put to the test.

Lowe ascended in his captive craft from the grounds of the Smithsonian Institution in Washington and described the scene to President Lincoln over a telegraph wire extending from the balloon's basket to the White House. The President immediately sent a note to General Winfield Scott who gave Lowe the opportunity to put his balloon to work for the Army of the Potomac. In May, 1862, he went aloft from the outskirts of Richmond and telegraphed Confederate troop positions back to General Heintzelman. This allowed Union intelligence to ascertain best locations for crossing the Chickahoming River. Sixty-four overlapping photographs were also obtained, giving a complete picture of the Richmond area. This was the first time panoramic photographs were taken of enemy ground emplacements.

Lowe supplied intelligence to the Union Army during the battles of Fair Oaks, Gaines Mills and Fredericksburg. In on reconnaissance he spotted an enemy balloon. He telegraphed directions to a patrol below. It reached the area from which the rival balloon was being elevated and captured both the ground crew and its balloon. General Longstreet later said that the last silk dress in the Confederacy went into that balloon's fabric and he called the capture ". . . the meanest trick of the war and one I have never yet forgiven."

Aerial communications (p. 40) did not begin with Lowe. The first recorded instance of aerial observation of a battle occurred in Belgium in 1794. Captain J. M. J. Coutelle hovered above the battleground at Fleurus, using flags with which to inform Napoleon of enemy positions. Napoleon had this aerial aid for four years; the balloon eventually was destroyed during a naval battle near Egypt. —Benedict A. Leerburger Jr.

Reliability—Everyone has a different picture of reliability. To millions of us, it means an unthinking faith in the slender steel ropes that hoist an elevator car. To the captain of a ship, it's a staunch steel hull that will resist the wrack of any storm. To the policeman on the beat, it's the oil-smooth action of a steel revolver that must never fail.

So it is that whenever man decides to make something that is completely reliable, he usually makes it from steel. The reason is simple: steel is the strongest, toughest material on this planet that can be bought at a reasonable price.

More than that, it's so easy to *use*. With heat treatment, most steels can be made soft enough to work, then strong enough to carry the load, then tough enough to take the pounding of any application. With many steels, you can achieve 100% efficient welded joints. All this in a material that is universally available, in an infinity of grades, shapes, sizes, finishes and preforms.

Ironically, the great *variety* of steels often causes trouble for the designer. No matter what combination of properties you need, no matter what the application, there is theoretically one best steel for the job. Finding it among the great family of Carbon, High Strength, Alloy and Stainless Steels can be a problem unless you have a skilled metallurgist on your staff, or unless you take advantage of the free services of a company that has invested hundreds of millions of dollars in steel research–this is United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS United States Steel

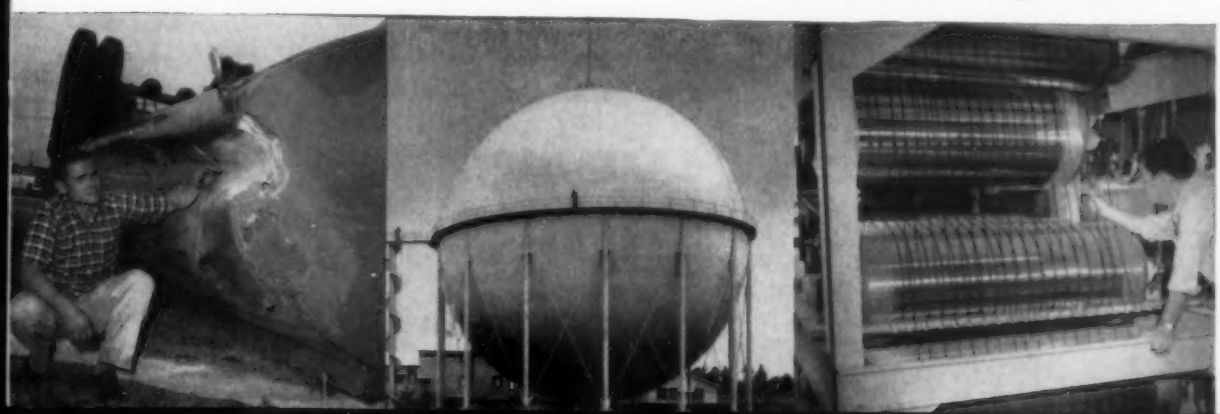
STEELS FOR DESIGN

Lower Left—Problem: Combine maximum pay load and safety in gasoline tank trailer. Solution: Tuttle Mfg. Co. in Los Angeles recommended USS COR-TEN High-Strength Low-Alloy Steel, well known for its ability to increase pay loads without sacrificing strength or reliability. Pay-off: Entire side of tank was caved-in in freeway crash, but the COR-TEN Steel didn't crack or tear. Cargo was saved and possibility of fire averted.

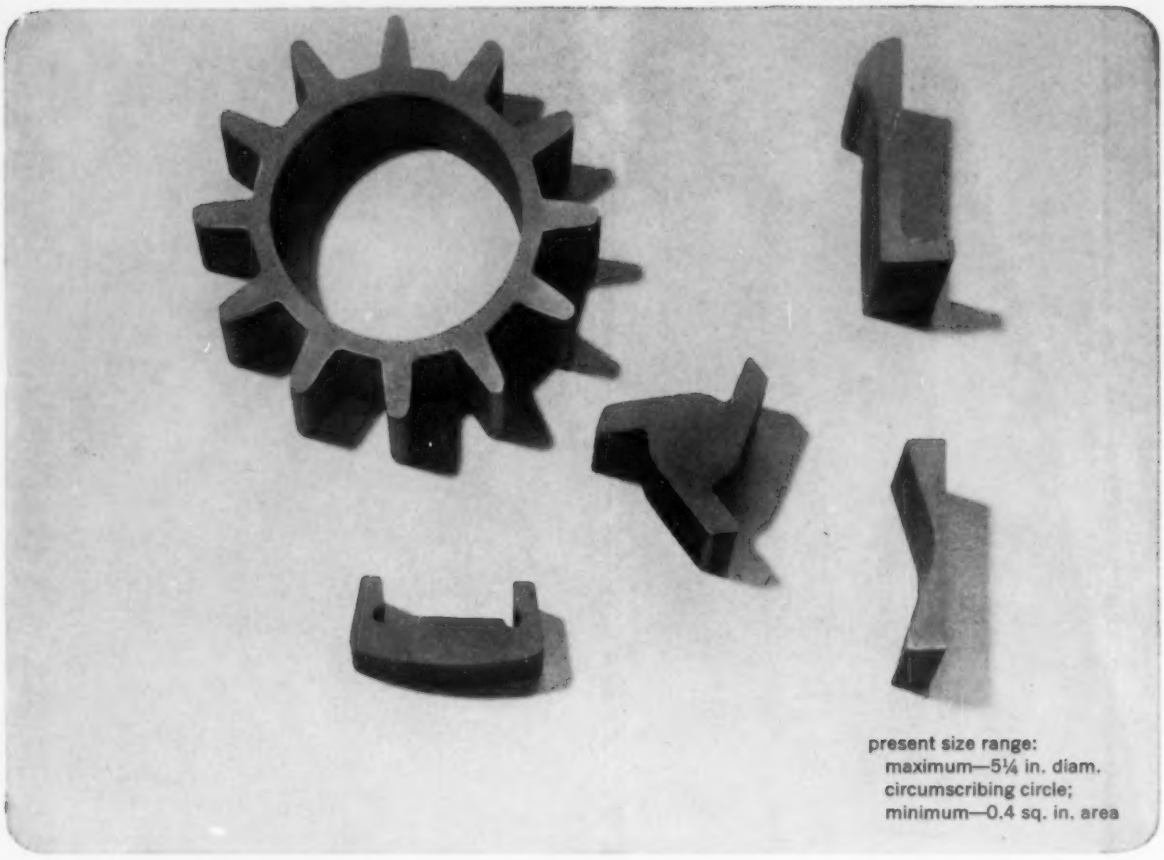
Lower Middle—Problem: Build completely reliable high-pressure natural gas storage vessels for Tokyo Gas Works Ltd. and save on steel. Solution: Vessels were built from USS" T-1" Constructional Alloy Steel. Plates were cold-formed and welded with a 90% joint efficiency factor. Pay-off: Due to the high allowable working stress (36,000 psi), they saved 1,720 tons of steel.

Lower Right—Problem: Design for a textile plant a 100% continuous steam process for vat dyeing that would insure exact color fidelity. Solution: Stainless Steel—its dense surface insures ease of cleaning, complete absence of color contamination. Pay-off: With the old equipment, dyeing was limited to one shade because it couldn't be adequately cleaned. The new Stainless equipment simply needs to be flushed out with hot water and it is clean enough for a new color.

USS, "T-1" and COR-TEN are registered trademarks



Experience**—the added alloy in **A-L Stainless, Electrical and Tool Steels



present size range:
maximum—5¼ in. diam. circumscribing circle;
minimum—0.4 sq. in. area

- 316 Stainless
- 304 Stainless
- Tool Steel Atlas 93
- SAE 4130
- 410 Stainless

Why hog out intricate shapes like these? Let A-L extrude them in any steel

If you're hogging out sections, paying for special mill rolls on small orders, or waiting for minimum rolling mill tonnages, Allegheny Ludlum Steel Extrusions are your answer. They will save you scrap loss, slash your machining costs, hold down your inventory requirements and cut delivery time.

Extruded shapes save money on expensive materials and on costly machining. Non-ferrous applications in the last decade have proven it. Now even greater savings are possible with tough, strong metals in Allegheny Ludlum Steel Extrusions.

Intricate extruded shapes in all stainless grades, tool steels, carbon steels, electrical steels, high temperature alloys, even zirconium and nickel alloys are now in production at Allegheny Ludlum, cutting costs in many different industries.

Costs and minimum order quantities are surprisingly low. Charge for die design is under $200. Orders taken for as little as 40 pounds.

To learn more about the time and cost-cutting possibilities of Allegheny Ludlum Hot Steel Extrusions, send for the extrusion booklet—12-pages of design and engineering information with process and product explanation, material properties, design tips and limitations, tolerances, order instructions, etc. Or call any A-L office for technical assistance. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*** Address Dept. PE-9A.

WBW 7110

ALLEGHENY LUDLUM

for warehouse delivery of Allegheny Stainless, call RYERSON

Export distribution: AIRCO INTERNATIONAL

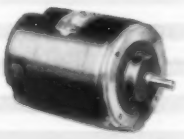
EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

DESIGN FLEXIBILITY
plus PROVEN PERFORMANCE...

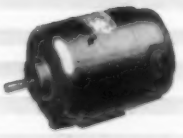
R&M UNIVERSAL MOTORS

foot mounting

end mounting



pad mounting



When you build-in R&M Motors... you build in customer satisfaction

R&M Universal Motors have proven to be dependable performers in hundreds of OEM products used by millions of satisfied customers. You can be sure your product will give more years of reliable, trouble-free operation if it's powered by R&M.

Design engineers prefer R&M Universal Motors for their broad design flexibility. Consider these variables on standard models: AC or DC operation . . . 1/50 to 1/2 hp . . . pad, foot or end mounted . . . rotation in either direction . . . open or totally enclosed. Custom designs with special ratings are also available.

Build customer satisfaction into your next product! Write today for R&M Bulletin 444-PE!

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO | BRANTFORD, ONTARIO

Robbins & Myers build motors from 1/200 to 200 horsepower

LIMA Crane uses USS Shelby Seamless Tubing for strong, lightweight boom

The giant 190-foot-long boom on this Lima Type 802 Crane is strong and rigid, yet remarkably light in weight and completely maneuverable. The Construction Equipment Division of Baldwin-Lima-Hamilton Corporation, Lima, Ohio, fabricated the boom from USS Shelby Seamless Steel Tubing made of very high-yield-strength USS "T-1" Steel. They state many advantages are accrued because of the use of "T-1" Steel Tubing:

- a stronger boom with less weight
- a longer boom without affecting the rated stability of the machine
- no auxiliary help needed in hoisting the boom from the horizontal

Shelby Seamless Mechanical Tubing in all steel grades offers strength and rigidity in perfect proportion to its size and weight. Moreover, it is shock absorbent, uniform throughout, and dimensionally accurate. All Shelby Seamless Tubing is produced under exacting quality control standards and to rigid specifications.

Consult our engineers about the wide range of shapes, diameters, wall thicknesses and steel analyses available. They can help you adapt Shelby Seamless Mechanical Steel Tubing to your particular requirements.

USS, Shelby and "T-1" are registered trademarks

"The world's largest and most experienced manufacturer of tubular products"

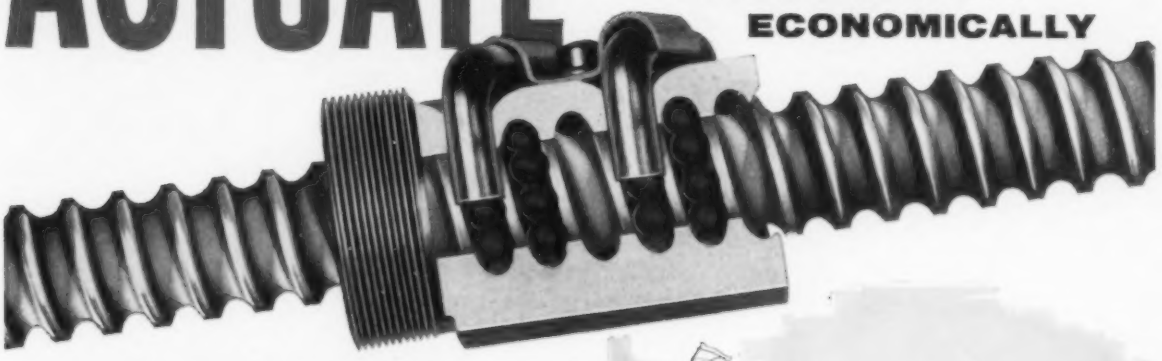
National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Supply Division • United States Steel Export Company, New York

CIRCLE 107 READER SERVICE CARD

ACTUATE

MORE QUICKLY . . .
EFFICIENTLY . . .
ECONOMICALLY



ROLLED THREAD
SAGINAW b/b SCREWS
Give Volume Products New Production and Sales Advantages

Because Saginaw employs an important anti-friction principle—steel balls recirculating in closed-circuit raceways—b/b Screws provide efficiencies of over 90%—perform up to *5 times* better than acme screws. Saginaw b/b Screws require far less torque—save up to 85% on operating power or manual effort. They are smaller and lighter than comparable units—permit smaller motors and gear boxes; often eliminate clumsy auxiliary parts. May be used with flange, trunnion, worm wheel or torque tube adaptors. Smooth, almost frictionless operation assures long, trouble-free performance, even in extreme temperatures and with lack of lubrication.

"OFF-THE-SHELF" STOCK REDUCES COST

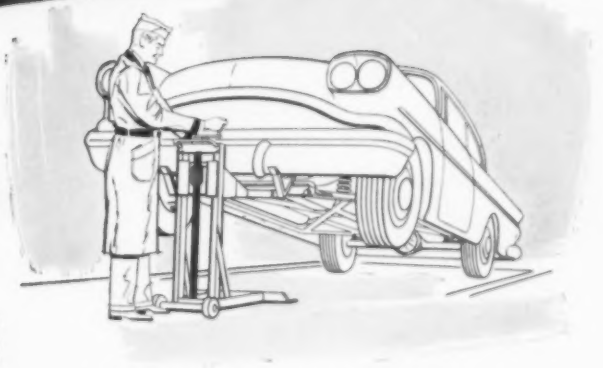
Saginaw b/b Screws are the only kind stocked in seven commercial rolled thread sizes, in 6-inch increments of length (up to 4 ft. for .375" BCD, 8 ft. for .631" BCD, and 11 ft. for all larger sizes.) Ball Circle Diameters are as follows:

.375" .631" 1.000" 1.171" 1.500" 2.250" 3.000"

MANY TYPICAL APPLICATIONS

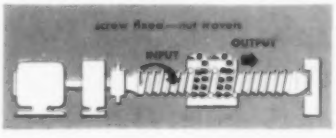
Saginaw b/b Screw standard assemblies have been successfully applied to such products as bumper jacks, automatic garage doors, automobile seat adjusters and window lifts, beauty parlor chairs, hospital beds, and circuit breakers. They are also being used in heavy industrial equipment like die table positioners, drill presses, lift trucks and welding machines.

FREE ENGINEERING HELP FOR YOUR SPECIAL APPLICATION



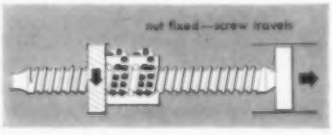
With a Saginaw b/b Rolled Thread Screw in the jack, just a spin of the handle raises a heavy car easily . . . smoothly . . . safely.

HOW THE WORLD'S MOST EFFICIENT ROTO-LINEAR DEVICE WORKS



NUT TRAVELS: When rotary motion is applied to the screw, the b/b nut glides along the axis of the screw on rolling steel balls, converting rotary force and motion to linear force and motion with 4/5 less torque.

SCREW TRAVELS: When rotary motion is applied to the b/b nut, the screw glides along its longitudinal axis on rolling steel balls, converting rotary force and motion to linear force and motion with new efficiency.



LET SAGINAW'S EXPERIENCED ENGINEERS HELP SOLVE YOUR SPECIAL APPLICATION PROBLEMS . JUST WRITE OR PHONE US—NO OBLIGATION

Saginaw ball/bearing Screw

SAGINAW STEERING GEAR DIVISION • GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN

Graph-Mo® dies cut downtime 50% on deep draw for round vacuum cleaner!

ENGINEERS at The Hoover Company had a tough problem in getting that round vacuum cleaner shape in the new Constellation. The two circular dies that form the hemispheres often galled, picking up bits of the steel being formed. This scored the dies, marred the finished parts. Production had to be shut down while the dies were repolished. And extra polishing of the hemispheres ran up costs still more.

After studying the problem, Timken Company metallurgists recommended dies made from Graph-Mo®—a special tool steel developed by the Timken Company. Results were outstanding. The new Graph-Mo dies cut downtime 50%. The combination of free graphite particles and diamond hard carbides in its structure make it outwear other tool steels 3 to 1. Production rolled smoothly and refinishing time was cut.

Graph-Mo machines 30% easier than conventional tool steels. And its uniform response to heat treatment eliminates distortion—saves time and money in lots of tough jobs.

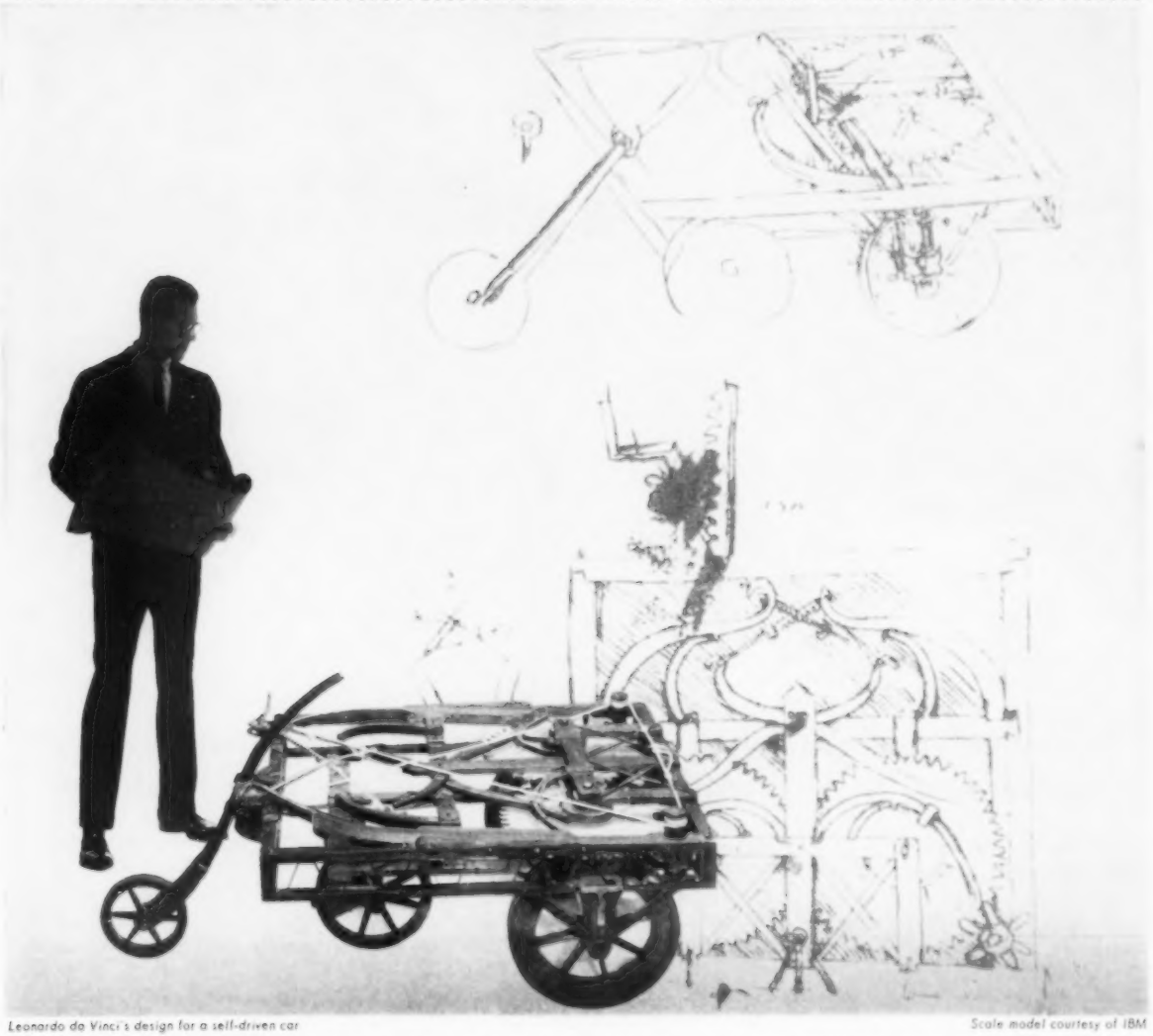
Graph-Mo is one of four graphitic tool steels developed by the Timken Company. If you would like more information about their uses in dies, punches, gages and machine parts, send for the new Timken Graphitic Steel Book. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN *Fine Alloy* **STEEL**

TRADE-MARK REG. U.S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

creative designing calls for an open mind



Leonardo da Vinci's design for a self-driven car

Scale model courtesy of IBM

EVEN DA VINCI'S SELF-DRIVEN CAR COULD HAVE BEEN BETTER WITH HELP FROM AN SKF ENGINEER.

When you receive the recommendations of an SKF engineer, you know they are in no way determined by possible restrictions in his product line. That's because the SKF line includes all four types of ball and roller bearings, in many thousands of sizes. This gives every SKF engineer the kind of flexibility he needs to keep an entirely open mind on any bearing problem. Give us your problem and see. 7858

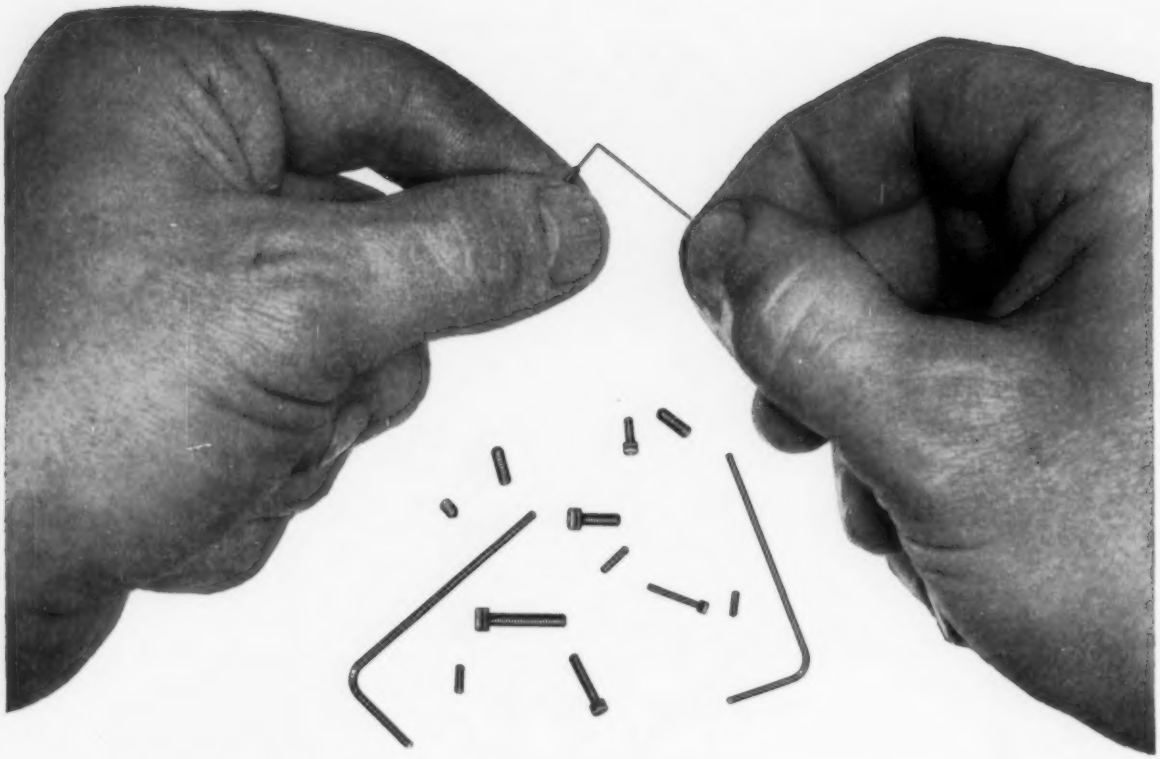
Spherical, Cylindrical, Ball, and Tyson® *Tapered Roller Bearings*

EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

®REG. U. S. PAT. OFF.



If you're miniaturizing . . . you'll save space, time and money with Allen Minicaps and Minisets (#0 thru #3 dia.)

These miniature Allen Hex Socket Cap and Set Screws will let you scale down your product sizes even farther. They're made from Allenoy special alloy steel — so strong that you can safely specify fewer screws or smaller sizes.

Allen Minicaps and Minisets are tiny, but very tough! — true Allens, with deep, clean, strong sockets and uniform Class 3A threads. Minicaps have the Allen knurled "Grip-Head" and are trimmed both on top and *under* the head, for tighter fit and better appearance. Minisets have the improved small-cup Allenpoint that drives deeper and holds tighter.

Because sockets are uniformly true hexagon shape, the key or driver fits tight — makes starting much easier, saves a lot of time in assembly.

Diameters of these miniatures run from #0 through #3. Minicap lengths run from ⅛" through ½", and Miniset lengths from 1/16" through ¼". Also standard in stainless steel. Your Industrial Distributor has them now. He'll show you why these Allens — like all Allens — hold tighter and last longer. Or write for information and samples.

Use Minicaps and Minisets wherever you need dependable fastening in very small assemblies:

TV, radio and telephone equipment • Guided missiles, rockets • Panel meters • Electro-mechanical devices and servo-systems • Computers • Control and operating mechanisms for relays • Cameras • Instruments

Stocked and sold by leading industrial distributors everywhere

ALLEN MANUFACTURING COMPANY
Hartford 2, Connecticut, U.S.A.

ALLEN HEX-SOCKET SCREWS HEAD

CIRCLE 111 READER SERVICE CARD

CIRCLE 112 READER SERVICE CARD→

d'Arazien

Alcoa puts the metal where you want it

This shell for a Dyna-Empire, Inc. hearing aid button speaks loud and clear to *everybody* concerned with precision in screw machine parts. No larger than a penny, with walls only .006″ thick, machined to within .001″ tolerances, it proves just how precisely we put the metal where you want it.

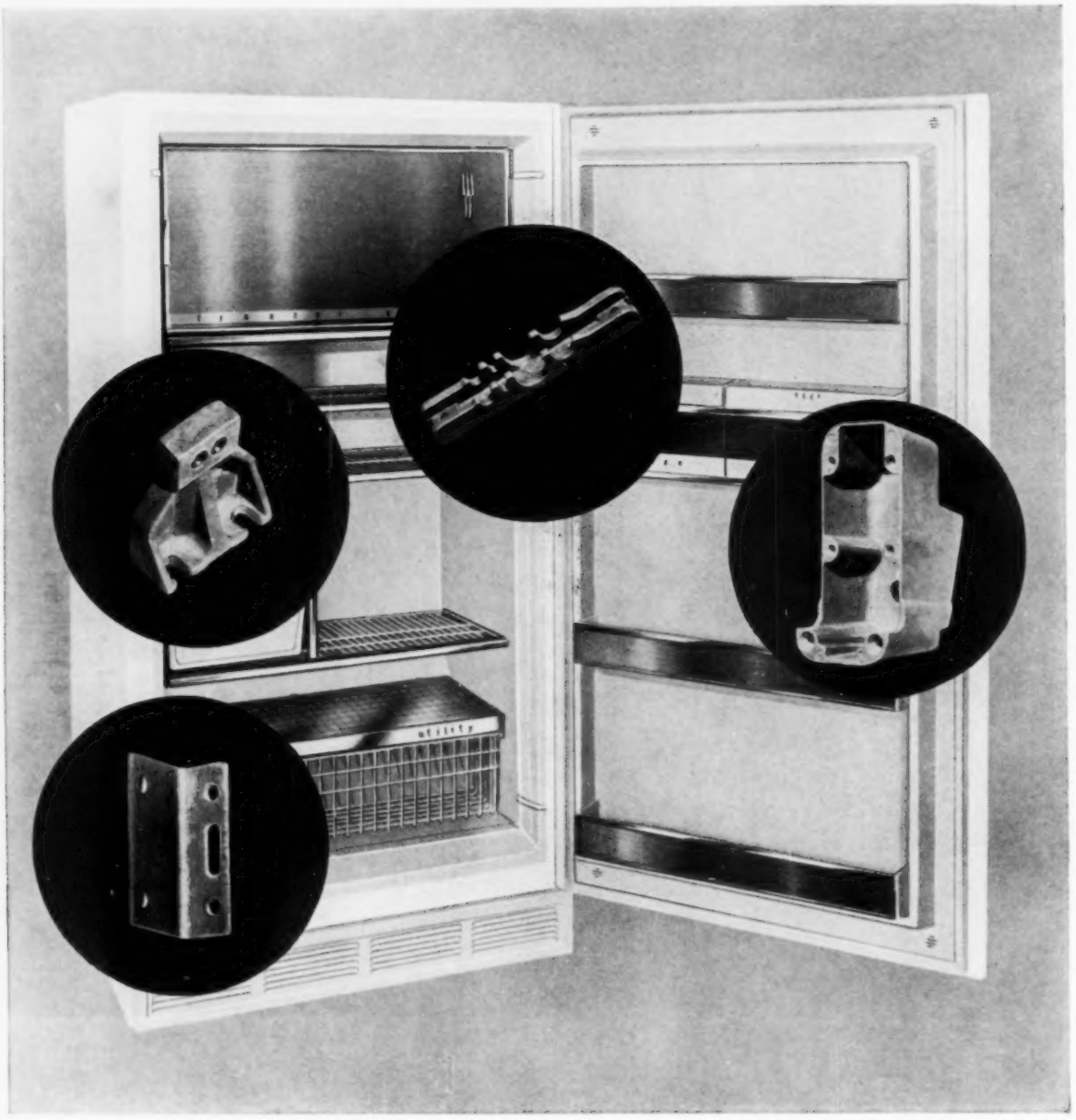
Others tried to machine this "impossible" part. The scrap generation of 87 per cent and blistering heat in the thin sections licked them. Our solution: a special set of tools; a whopping knowledge of machining aluminum. And now these parts come shucking out at a tidy 300 per hour. The delicate pink anodized color and bright buffed finish on the outside show our skill in secondary operations at Lancaster, Pennsylvania.

In screw machine parts as well as forgings, castings, extrusions and impacts . . . Alcoa puts the metal where you want it. To you this may mean fewer rejects or ingenious design solutions . . . less waste in production or a product that sells faster. Start now; write for Alcoa's Up-to-Dater, a starter file of ideas and design tips on Alcoa Engineered Products. Aluminum Company of America, 951 Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM

Alcoa puts the metal where you want it — in castings, forgings, impacts, extrusions and machined parts.

"ALCOA THEATRE"
FINE ENTERTAINMENT
ALTERNATE MONDAY EVENINGS



Kelvinator gets big benefits from premix moldings

Premix moldings are making an important contribution to performance of Kelvinator refrigerators.

Strike mounting plates, tie-straps, tubing retainers and lock housings for the Kelvinator are all premix moldings. They've proved tough and resilient . . . excellent shock absorbers. And their thermal insulating properties contribute to the economical operation of the refrigerator.

When resins and reinforcing fibers are blended beforehand, moldings are stronger, wall thicknesses more uniform, weak spots are eliminated. Small and large, simple and complex, premix moldings are not only improving products but cutting costs for hundreds of manufacturers.

If your product calls for strong, rigid, reinforced plastics, look into premix moldings made with Dow vinyltoluene or Dow styrene. Get the names of molders and suppliers from your nearest Dow sales office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Dept. 2207K.

YOU CAN DEPEND ON DOW

DEVELOPMENTS

TO WATCH...

New resins that resist heat . . .

. . . are coming from a research program now under way at the Bureau of Standards. Says NBS: "a number of new fluorinated organic and semiorganic compounds have been successfully synthesized . . . one of which, a fully fluorinated polyphenyl, appears to be very stable to thermal degradation."

Next step: exposing this and other resins to temperatures in the 3000-F range to find out how they break down; gain new data to build up polymers that will stand up.

(For information on other approaches to the problem of creating heat-resistant plastics, see *PE—July 21, p 18; May 19, p 20; Apr 7, p 5.*)

NBS is also working on metals for high-temperature service, and specifically on methods for increasing the tensile strength of such materials as the precipitation-hardening stainless steel at temperatures in the 800 F range. Results of research thus far, NBS says, indicate that these steels can be heat-treated for a tensile strength of 225,000 psi (yield of 200,000 psi) at room temperature and will retain 75% or more of that figure to 800 F.

Metallized paper, competitive in price . . .

. . . with foil-paper laminates, is promised for late this year by Vaculite Corp, Cambridge, Mass. Advantages of metallized paper as compared with laminates, Vaculite says, are better bond, greater ease of handling in processing equipment. Possible applications: electrical capacitors, reflective insulation.

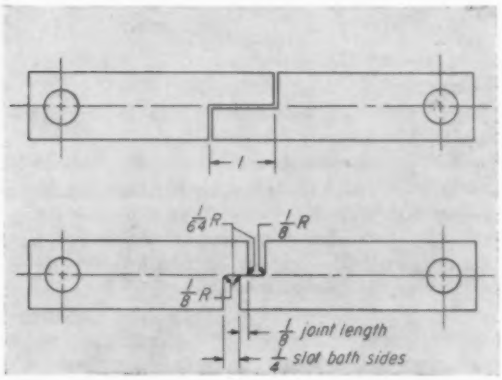
While the idea of using metallized paper in capacitors is not new; it has not made too much headway. But availability of a new type and source of supply might change the situation. Vaculite, incidentally, is the new company formed jointly by National Research Corp and Champion Paper & Fibre.

New design standards may result . . .

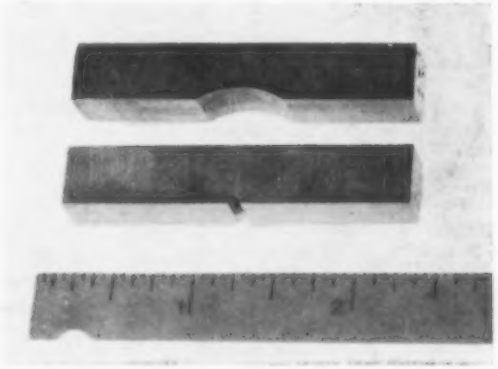
. . . from new testing methods now being proposed for brazed joints and tool steels.

The proposal originally made by Wall Colmonoy Corp at last spring's AWS meeting for an industry standard of shear strength for brazed joints, is now to be evaluated by a special AWS subcommittee. The suggested specimen design (see diagram) may require modification, but an industry-wide survey indicates a strong demand for such a standard.

In regard to tool steels, Crucible Steel Co notes that a greater spread of hardness values can be obtained, making it easier to distinguish between tool steels, when a cylindrical notch is substituted for a standard V. Crucible suggests the design below.



Shear-test samples for brazed joints could be prepared as indicated here. At left are notched bars before brazing; at right, sample prepared for test.



New way to measure toughness, proposed by Crucible Steel, uses cylindrical notch (top specimen) instead of the V that is now standard for Charpy impact tests.

DEVELOPMENTS TO WATCH...

Scratch-resistant, transparent acrylic plastics . . .

. . . for instrument faces, aircraft canopies, safety lenses, and the like, are promised by a new coating technique developed at Bjorksten Texas Research Co., 2405 Norfolk, Houston 6, Texas. Bjorksten engineers have found a way to bond a very thin, transparent layer of nylon to the surface of the acrylic; providing, Bjorksten says, an optically clear material with a high degree of abrasion resistance. The composite sheet also resists crazing by organic solvents, another "ill" to which acrylics are notoriously subject. The process has been patented, and is being licensed for use.

A device that works like a torque meter . . .

. . . and indicates directly the braking torque developed by a permanent magnet of the type used in electric meters, has been developed by an Italian firm, SpA Vizzola, Milan. The device consists of twin, small synchronous motors which drive, through a Willis couple (epicyclic train gearbox), an aluminum disk. The disk is attached to one of the gears in the train; an indicator loaded by a spiral spring to the other. A conventional graduated dial, with 150 divisions, is used.

The magnet under test is placed on a slide which can be pushed against adjustable stop-dogs to position it in respect to the aluminum disk. As this is done, the indicator moves through an angle proportional to the braking couple generated by the magnet, and the rating is read from the dial.

Plating process that will coat, but not plug . . .

. . . the holes in porous parts is claimed by Metals Research & Development, Inc, Exeter, Penna. "By this method," says the company, "an inexpensive base metal, such as iron . . . can be given a coating which will protect it against extremes of corrosion, and the process can be adapted not only to porous parts such as filters and self-lubricating bearings, but also to more-solid components."

Waxes from sugar cane that may be able . . .

. . . to replace imported carnauba, ouricuri, and candelilla are being developed by US Dept of Agriculture researchers. They foresee new types of coatings, carbon paper waxes, and a variety of fillers and bonding agents.

Many byproducts are now obtained from sugar cane, but fine waxes like carnauba have not been produced because no economical separation process was available. Now, the USDA's Southern Research Laboratory at New Orleans believes it has such a process and says results from pilot experiments are good enough to warrant large-scale tests.

Can iron-aluminum alloys . . .

. . . take the place of stainless steel? Metallurgists at Martin Company's Nuclear Div think maybe so. As they point out, iron-aluminum alloys show remarkable resistance to high-temperature oxidation; and, with moderate chromium additions, to atmospheric corrosion as well. But they've been held back by poor ductility at room temperatures, low strength at elevated temperatures, and difficulties in welding.

Recent studies, though, throw new light on the reasons for these limitations (among them, a tendency for a structural change in alloys containing 13 to 21% aluminum by weight; and a propensity for grain growth at high temperatures), and the Martin researchers think these limitations can be overcome. Already, they report, several experimental alloys (notably, a 5.5% Al-9% Cr and a 7.5% Al-5% Cr) "compare favorably in strength and ductility at both high and low temperatures with the ferritic stainless steels" and, "in high-temperature service, their superior oxidation resistance recommends them for immediate use where high-temperature strength must be combined with oxidation resistance."

—ARG

IT'S NOT JUST US:

Education Worries Soviets Too

LONDON—The Russians are expressing "constructive dissatisfaction" with their schools. Under scrutiny are the relation between theory and practice in technical courses; the place of art, literature and the humanities in the curriculum; and the facilities for training students in new technologies.

V. P. Yelyutin, Minister of Higher Education, boasts that the Soviets lead the world in output of specialists. Still, he says, they need to expand training in such new fields as computer techniques, radio engineering, dielectrics, transistors, automatic control of production processes and instrumentation. In these departments, students should be getting more intensive theoretical training.

College and production experience should be more closely mated, Yelyutin believes. This is regarded as a major problem in the Soviet Union. During the initial two or three years of higher education, he proposes to combine study and work around a flexible plan that allows days, even years between the theoretical and practical phases.

Evening and correspondence courses, Yelyutin suggests, should focus on the humanities rather than technical pursuits. "It is necessary," he says, "that people engaged in useful work should be able to attend in their spare time institutions where they can study the arts and humanities."

In general, the Soviets seem to be striving for a system that is liberal, yet specialized; flexible but tailored to the needs of industry.

In their bout with a planned economy they have produced 4 million technologists, including a million fully trained engineers. This year alone their educational system anticipates a harvest of 290,000 top-qualified specialists, including 90,000 engineers. More than 500,000 students—about one-quarter of the nation's student body—are attending teachers' colleges. And 880,000 of the country's 2 million students are supplementing their regular studies with evening and correspondence courses.

The problem of training youth is not entirely circumscribed by school walls. One educator, S. Seryegin, bitterly complains that graduates are often diverted to other fields.

Some economic councils avoid employing young people lacking industrial experience. Standard brush-off for the untrained is "no living quarters." The difficulty youth faces in getting the plant experience it needs to mature is illustrated by a recent conference of young workers at the Alma-Ata Mechanical Works. Of the 15 participating, only one worked directly in the shop—and not because the young people wanted it that way. Average age of foremen is 50. Many foremen obviously were trained too early to have the theoretical background for modern technology.

The educational mechanism at present does not always precisely match the need with supply of technical people. One area needed 71 foundry engineers, but got 26. The same area sorely needed specialists for the electric industry and for ferrous and nonferrous plants, but got none.

Yelyutin's ministry, itself, is under fire for the imperfect balance of need and supply. High schools are accused of preparing students for careers in obsolete fields while specialists in electronics and automation are desperately essential. Higher up the education scale, only one institution, the Moscow Power Institute, can graduate engineers in automation techniques.

Recent criticism of education is probably not a prelude to wholesale personnel changes. Rather, it's part of a Soviet attitude, "This could be better; how are we going to do it?"

In the view of one critic, Premier Khrushchev's industrial decentralization order of last year is pointing the way for improvements: "It is not accidental that it is precisely in the current year, after the reorganization of management of industry, that the shortcomings of the planning of engineering and technical personnel have been brought out so saliently. Previously, young specialists were distributed mainly from above. The State Planning Committee distributed the entire contingent of graduates among various ministries and departments, and the ministries distributed them among the enterprises, often without regard for their actual needs."

Inertial Navigation Without Stable Platform

LONG ISLAND CITY, N. Y.—Ford Instrument Co, div of Sperry Rand Corp, Long Island City has a contract from the Weapons Guidance Lab at Wright Air Development Center for a no-gimbal inertial guidance system. The expected advantages: lower weight carried by the missile since no platform is necessary; greater accuracy.

Inertial guidance has always required a stable platform on which three accelerometers and three gyros are mounted. The gyros sense rotation around three axes and their signals direct servos to hold the gimbal-mounted platform in a fixed position relative to inertial space. Accelerations in any of the three axis directions are then measured, integrated twice and read out as spatial position.

Based on mechanization of the mathematical equations which describe the six spatial degrees of freedom, and a digital computer to solve the equations, the new system bypasses the errors inherent in heavy gimbal drives, as well as servo and alignment errors. Size, weight, and expected accuracy of the new system are classified. New types of accelerometers, and gyros will be used.

Improve Fifth Wheel

DETROIT—A redesigned fifth wheel that establishes rolling connection between a truck tractor and trailer is expected to give drivers a smoother ride and increase their efficiency. The redesign, based on recent vibration studies, is the work of Janeway Engineering Co. and Freightliner Corp. of Portland Ore.

The new fifth wheel is convex in shape at the trailer side and mounted in a matching concave part on the

Cradle-mounted 5th wheel . . . is shown tilted forward. Length of rocking motion is indicated by stop at left, center.

tractor side. It rides on rollers. This design raises the center of curvature for the concave and convex members above the driver's head to a position at which the wheel's pitch axis comes close to the truck's center of gravity. At such a position the vehicle's dynamic index is increased and vibration, transmitted from the trailer to the tractor, is reduced.

Need for a redesigned wheel has been pointed out by the SAE. A special SAE subcommittee headed by R. N. Janeway, a consulting engineer, recently reported on "Better Truck Ride for Driver and Cargo." The committee, formed at the request of the Automobile Manufacturers Association and the Truck Trailer Manufacturers Association, was asked to investigate the riding qualities of trucks.

The SAE study, Janeway says, showed that truck drivers can tolerate three to five times as much up-and-down as forward-and-backward bounce. Much driver jostling originates from the action of the trailer on the tractor. Impairment of driver efficiency from vibration adds both to the cost of operating trucks and to insurance rates.

The committee made several other design recommendations:

- Replacing stiff springs at both ends of truck and tractor with softer springs.
- Reduce friction of leaf springs by lubrication and spring covers.
- Make seat cushions of a material having high internal energy absorption to damp seat vibrations. When a driver sits in standard cab seats, his weight gives the cushions a natural frequency close to the frequency the truck and trailer get from the vehicle's suspension system. Such vibrations reinforce one another and total amplitude may exceed driver's limits.

Polystyrene Models Speed Design Tests for Investment Casting

CLEVELAND—A better way to test how parts will come through investment-casting procedure has been found by Precision Metalsmiths, Inc. This investment-casting company says parts can be developed most efficiently with successive models machined from polystyrene (see below).

As a substitute for the more expensive prototype patterns, this approach—literally a "cut-and-try" technique—permits alternative designs to be evaluated quickly, and different alloys tried for ease of casting and functional efficiency. If the proposed part is of relatively simple design, models are machined from polystyrene, then sent to the investment-casting foundry where they are cast exactly as they would be during a production run. If more complicated, the part is separated into components, each to be machined from polystyrene. Components are then assembled into a complete pattern with plastic adhesives.

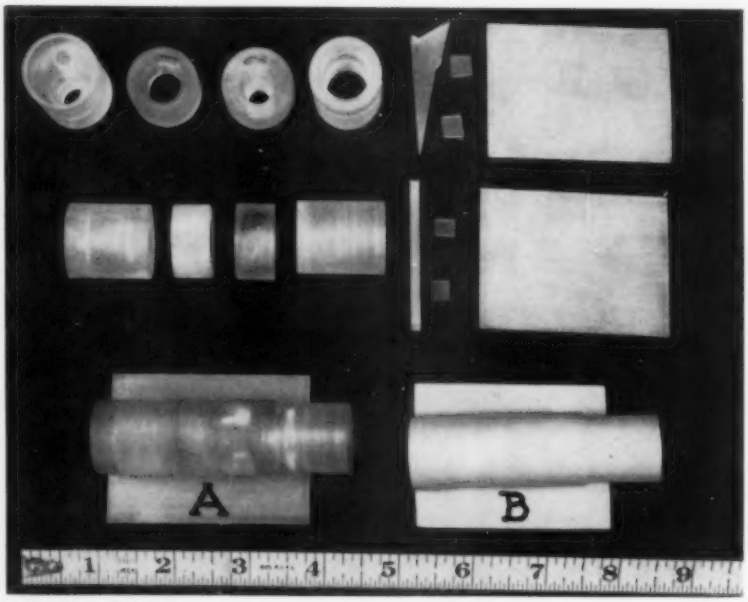
NO ELABORATE PREPARATIONS

Because most machine shops can produce polystyrene-machined patterns from simple sketches and verbal instructions, the technique permits testing a part even before drawings are made. Result: engineering changes not apparent in the design stage can be made inexpensively even after testing.

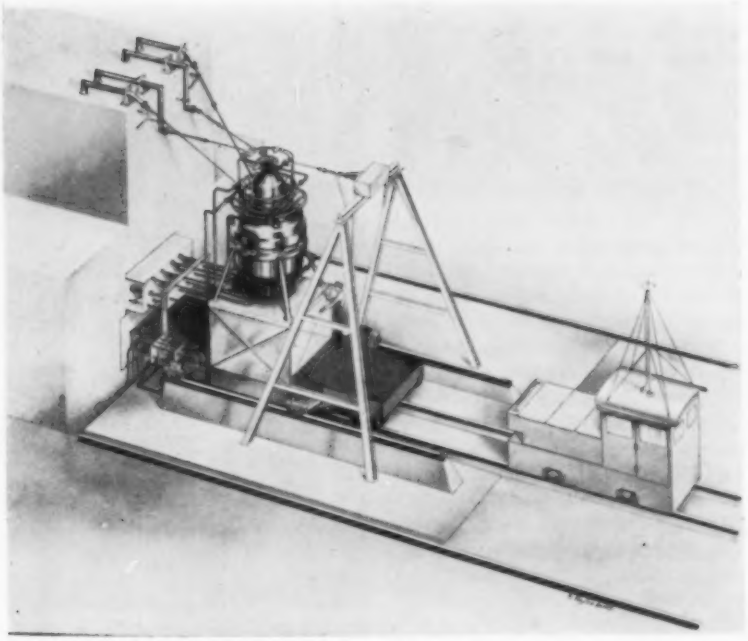
Chart European Plastics

NEW YORK—New plastic materials from Europe may be on their way to the American market. Robert S. First an industrial consultant, and Foster D. Snell, Inc, consulting chemists and engineers, are piloting a joint intelligence project to flag commercially significant European products for American clients.

The project covering the chemical, plastics, and pharmaceutical industries in England, France, Holland, Belgium, Italy, West Germany, Sweden, and Switzerland will end in a detailed report of products and processes available for license, the raw materials involved, US market potentials and technical feasibility. The study to be completed in about a year will be available on a subscription basis to a limited number of clients.



Adhesive does it . . . Top and center rows show two views of machined polystyrene sections that will be joined to form complete prototype pattern (A) for prototype casting (B).



Nuclear reactor for rocket propulsion . . .
is scheduled for static tests late this year at Los Alamos Scientific Lab facilities, Jackass Flats, Nev. Developed as part of Project Rover, Kiwi-A (named after the nonflying Australian bird) is shown in its test cell. Tests will probably run into 1959, are expected to provide vital information on high-temperature behavior of materials, fluid dynamics, nutronics, control and mechanical-design requirements for actual nuclear rockets. The reactor, unshielded and mounted to fire upward, lies on a test car that can be hauled (right) to a nearby assembly and disassembly building for examination.

Largest Self-propelled Earth-moving Scraper

LONGVIEW, TEXAS—R. G. LeTourneau, Inc., has completed the design of a line of the largest self-propelled earthmoving scrapers. To be available next month, the first models, like the one shown, right, will be in the 70 and 125-ton class, roughly equal to 50 and 100-cu.yd. capacity. In previous designs max capacity was 15-cu.yd. with a few capable of 35 cu.yards.

First public showing of one of the new 70-ton units will be at the American Mining Congress later this month. It will be the first showing of any earthmoving machinery by Le Tourneau since the company sold out its previous line in April 1953 (P.E. June 30, '58, p. 16).

The new self-propelled scrapers are the latest step in the development of this type of machine, originally pioneered by Le Tourneau in 1938, and can be expected to play a significant role in the country's multi-billion dollar road-building program. The first unit is being introduced at the Mining Show to demonstrate its application for large scale strip mining.

Major difference between the powerful, super-sized scraper and conventional scrapers is that each wheel of the new machine will have an individual electric motor geared directly to its inner rim, thus providing greater traction and working power under the payload than previously attainable. Power is supplied by the machine's 600-hp diesel-driven generator.

COMING EVENTS

SEPTEMBER

4-5 . . . . American Society of Mechanical Engineers, International Conference on Air Pollution, Hotel Statler, New York.

8-10 . . . . American Society of Mechanical Engineers & American Society of Civil Engineers, West Coast Conference of Applied Mechanics, Univ. of Calif., Los Angeles, Calif.

8-11 . . . . Society of Automotive Engineers, National Farm, Construction and Industrial Machinery Meeting, Production Forum and Display, Milwaukee Auditorium, Milwaukee, Wisc.

12-13 . . . . Society of Plastics Engineers, Plastics for the Automotive Industry, St. Clair River Inn & Country Club, St. Clair, Mich.

9-11 . . . . American Society of Civil Engineers & American Meteorological Society, Second National Conference on Applied Meteorology Engineering, Univ. of Mich., Ann Arbor.

15-17 . . . . American Institute of Electrical Engineers, International Conference on Computer Applications in the Power Industry. Sessions also will include the design of rotating and non-rotating machinery, King Edward Sheraton Hotel, Toronto, Canada.

15-19 . . . . Instrument Society of America, 13th Annual Instrument-Automation Conference and Exhibit, Philadelphia, Penna.

22-24 . . . . Standards Engineers Society, 7th Annual Meeting, Benjamin Franklin Hotel, Philadelphia, Penna.

23-26 . . . . Association of Iron and Steel Engineers, 1958 Iron and Steel Exposition and Convention, Cleveland Auditorium, Cleveland, Ohio.

24-25 . . . . Institute of Radio Engineers, 7th Annual Symposium on Industrial Electronics, Rackham Memorial Auditorium, Detroit, Mich.

Bits and Pieces

THE WEST GERMAN GOVERNMENT . . . has agreed to establish an Institute of Technology in Madras, jointly with the Indian Government. It will start operations in one year. A similar institute is being built by the USSR in Bombay and a third is planned in Kanpur.

STRESSING NEW-PRODUCT FEATURES . . . particularly those in appliances, leads to increased buying—according to survey made by Dr. Eva Mueller, Univ. of Mich. Survey Research Center. Among owners of appliances in unsatisfactory condition there was only a weak association between purchases and interest in new-product features the survey showed.

A SILENT PNEUMATIC RIVETER . . . reportedly has been developed in Communist China by increasing the air pressure so that a piston rod would complete the riveting at one stroke instead of as a pneumatic hammer operating by repeated blows.

HIGH-SPEED MEASURING . . . installation at the Physics Institute of the USSR Academy of Science is able to register speeds at one six-millionth of a sec, according to a Moscow report. It is reported to be 100 times faster than instruments now available. The device helps study electric processes in atomic nucleii.

SEND AN EMPTY BOTTLE . . . up 60 miles to collect air and what do you find? Almost none. Neon and helium were among the gases present, but in small quantities, and they increased in relative proportion at high altitudes. Helium present was 5 molecules per million of air. Work was done by Univ of Mich for the Army Signal Corps. Bottles similar to those used by skin divers were sent up in a rocket, then freed from the rocket and allowed to open and close at selected altitude.

SOME US SCIENTISTS AT MOSCOW . . . attending world scientific meetings there received unexpected windfalls of from 700 to 4,000 rubles apiece (official rate of exchange 1 ruble, 25¢; tourist rate, 10¢). This represented royalties on magazines or books published there. The catch: all the rubles must be spent in Russia.

Plutonium recycle reactor . . .
under construction at GE's Hanford Laboratories, is viewed in model stage by the Lab's manager, Herbert M. Parker and manager of reactor engineering, Robert M. Fryar. The reactor is being built to demonstrate that plutonium can be used as an enriching agent in place of the more expensive U-235, and to explore the best ways of using the plutonium. A pilot plant to assemble fuel elements is being constructed with the test reactor project.

MIT Reactor Goes Critical

CAMBRIDGE—A nuclear research reactor has gone critical at MIT. The reactor similar to the CP-5 at Argonne National Lab and to DIMPLE and PLUTO at Harwell installations of the British Atomic Energy Authority, is fueled with enriched uranium-235.

Designed for production of neutrons, the reactor will be used to train 100 students who are expected to enroll in MIT's new Department of Nuclear Engineering. It will also be available to local hospitals for medical research and treatment.

The reactor's flux—the number of neutrons passing a sq cm a sec—is 10^{13}, high for a research type reactor. Its aluminum core has positions for 30 fuel elements though only 22 are presently used.

Among investigations expected to be made with the reactor are studies of mechanical wear for such components as piston rings, research on new materials, studies of the effect of radiation on metals, other materials.

High flying oxygen . . .
is supplied by Linde Co's liquid oxygen converter. The converter presently is being used to supply oxygen to crew members of the B-52 heavy bomber.

LOX Converter for B-52

NEW YORK—A new 25-liter liquid oxygen converter for the Boeing B-52G is in production at the Linde Co.'s (Div of Union Carbide Corp) Speedway, Ind. plant. Known as the ME-3, the converter is made with a stainless steel inner shell and aluminum outer shell. It weighs 40-lb and can be installed in a space as small as 18⅝-in. high and 19¼-in. dia.

The vacuum space between the converter's concentric shells is insulated with a special insulation developed by Linde. The insulation is said to retard oxygen evaporation for from 5-6 hours in the event of a leak in the outer shell.

Under normal conditions the ME-3 supplies enough oxygen to sustain four men at altitudes above 35,000 ft for 30 hrs. The 25 liters of liquid oxygen convert to 21,525 liters or 760 cu ft of breathing oxygen. At operating pressure of 300 psig, the converter will deliver more than 150 liters of gaseous oxygen per minute.

The converter is designed to meet MIL spec C-25674 and will meet special severe vibration standards. The converter is guaranteed for one year against evaporation loss in excess of specs for a 24-hour period.

What's Your Rust Index?

CHICAGO—Rust costs American industry and homeowners $7½ billion a year. Some regions are more vulnerable to its attack than others and these geographical variations are now measured in a rust index worked out by Rust-Oleum Corp. It shows rate of rust for all US cities over 10,000 and is based on data collected over 25 years. The company's tests found that in the nation's fastest rusting cities—Miami; Erie, Penna; Buffalo and Rochester, NY—a piece of uncoated steel will corrode badly within 3 years. At other end of the scale, uncoated steel will last 15 years or more in Tuscon, Ariz., or Roswell and Santa Fe, NM.

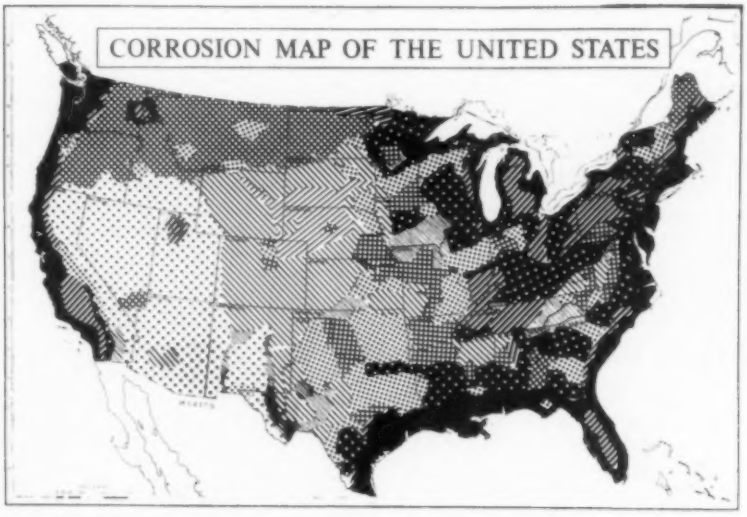
The control material used in the long tests is a 5 x 10-in. sheet of low-carbon, cold-rolled 28-gage steel. From such panels placed in 523 US cities and checked periodically came the nationwide rust index.

It shows that rust advances more slowly in rural than industrial areas. (Index for Iowa City, for example, is 8 years 1 month; for Pittsburg, 3 years 1 month.) Oxygen, water, and ultraviolet (sunlight), with some aid from wind and dust, are the ingredients of corrosion in farmlands. Their rate, of course, varies with amount of rainfall, sun, etc.

In urban areas, rust is accelerated by industrial gases, primarily compounds of sulphur that dissolve in the air. Dew, rain, or fog, when they mix with sulphur compounds, become weak acids and act as electrolytes that speed corrosion. Airborne chlorides, cinders, fly ash and chemical dusts also aggravate rust.

In salt water atmosphere, humidity and salt combine to cause rapid pitting on steel surfaces and weaken the structure more than uniform corrosion does. Most severe corrosion in coastal regions occurs on the splash zone—the steel surfaces that lie above high tide. This is where the material is both constantly wet and exposed to oxygen. Severe corrosion in Mobile or New Orleans will show in 3 years 1 month.

Of the sum lost each year from corrosion, the railroads bear $500 million, the study notes. Other major losses are the Navy, $100 million; farmers, $300 million; and homeowners, $1½ billion. Cables, pipes and foundations suffer $1-billion damage a year.


CORROSION MAP OF THE UNITED STATES
Legend
The number of years and months required to corrode an uncoated 28-gauge steel test panel to a severe degree
YEARS AND MONTHS
COLOR CODE
3.00 – 3.11
4.00 – 4.11
5.00 – 5.11
6.00 – 6.11
7.00 – 7.11
8.00 – 8.11
9.00 – 9.11
10.00 – 14.11
15.00 +

Corrosion map . . .
worked up by Rust-Oleum Corp shows the number of years and months required in various US areas for severe corrosion of uncoated steel.

Britain Steps-up Design on Sub Tanker

LONDON—Mitchell Engineering Ltd is proceeding full-speed ahead on its concept of a submarine tanker powered by a nuclear reactor. It has contracted for a feasibility study combined with preliminary design work, and now hopes it can offer customers a firm design in about two years.

The new work will be done by Sanders-Roe Ltd, the company that did initial hydrodynamic research on the project for Mitchell. When completed—in about eight or nine months—the data will be sufficient for work on final design.

Sanders-Roe studies will not include the power plant. This will be designed by Mitchell Engineering, which is financing all the tanker research itself, around a boiling-water reactor supplied by the American Machine & Foundry Co.

Economics of a submarine tanker involve savings from greater speed vs higher initial and operating costs. Mitchell is not yet prepared to offer cost estimates. The speed now thought optimum is about 35 knots, and 80,000 tons appears to be the most economical size.

Iron ore transport is forecast as probably the first use for a nuclear sub tanker—possibly out of Hudson Bay, where ice balks removal of ore by surface vessel for seven months out of the year. But Mitchell also reports much interest by oil companies. It predicts that a submarine trip from the Middle East via the Cape of Good Hope would show timesaving over a surface trip via the Suez Canal.

Computers Speed Design

PITTSBURGH—High-frequency equipment including pulse transformers for radar and pulse generators are being completely designed in minutes at Westinghouse Electric Corp.'s specialty transformer department.

Programs are now available to de-

sign transformers with pulse widths from ¼ to 16 microseconds, power ratings through 200 kw, turns ratios up to 20 to 1 and peak voltage ratings in excess of 200 kv. Such units generally are used as interstage grid drivers or output transformers.

In producing a design, the computer compares specifications for a new transformer with information stored in its memory bank. The computer then assumes a general design and proceeds with design calculations until it reaches a point where characteristics of the assumed unit are outside the specifications. It then automatically repeats earlier steps adjusting physical quantities and proportions so that design is compatible with specifications.

The method gives Westinghouse engineers intermediate design values to use while working toward the final design. With these, the engineers can study the effects of parameter variation on transformer design.

Westinghouse says design by computer offers several advantages to the customer:

- Faster design means faster delivery.
- Design consistency is achieved because the computer uses the same philosophy on all designs.
- Design quality is improved because more precise limits within the program are maintained.
- During negotiation stage computers can give design data quickly.

Now a plane, now a missile

Lockheed's new Kingfisher target missile provides Army with first realistic test of a defensive missile. Artist's conception shows how it can simulate electronically a variety of missiles and aircraft (phantom below) without itself being damaged. This enables Army to test defensive missiles at a fraction of the cost of methods in which expensive target birds (World War II bombers) are destroyed. Ultrasonic speeds are also achieved. Equipped with electronic scoreboard to record automatically either hits or mis-distance, and pass angle of the interceptor, Kingfisher was recently "knocked from the sky" by the missile Talos during test at White Sands Missile Range in New Mexico.

READER TO EDITOR

Russian *English*

Looks a Little Similar

To the Editor:

I thought you would be interested in seeing my English Hoover washing machine model 0319. It looks like a deadringer for the Russian model you published in your Moscow issue (July 14, p 29).

—OLIVER BALL
Nottingham, England

ED.—*"They copied all they could follow, but they couldn't copy my mind, so we left them sweating and stealing a year and a half behind."* —*Rudyard Kipling*

Five-sided V-belt

To the Editor:

Mr. H. Koslow suggests (July 28, p 42) a "V-belt made with five sides instead of the usual four . . . . the belt could be rotated periodically to distribute the wear equally on all sides."

The elimination of periodic rotation would seem to have some merit. Why don't they research and develop this type of belt in which the molding process incorporates a ½ turn at the joint (a la Mobius) to produce self-rotating guaranteed to equalize wear of drive belting. I agree that the molding of such a twist is more complicated than that of a five-sided belt but the advantages are interesting if it could be done.—J. D. CAMPBELL
Remington Arms Co, Inc
Ilion, N. Y.

Torsion Springs Not New

To the Editor:

You say, "torsion bar springing, introduced with the Morris Minor in 1948 and used by British Motor Cars, has not been adopted elsewhere" (July 7, p 19). Torsion bar suspension has been used on the Citroen, Jaguar, Riley, Bristol and many others.

—R. S. ELLIOTT
Chief Engineer
North American Marine
Warsaw, Ind.

• *The article was published just about the way our London editor sent it in and the error slipped past several editors who certainly should have caught it.*—ED.

Speed Control for Cars

To the Editor:

In the June 30 issue (p 34) the item in "Why Don't They Research and Develop" concerning an auto governor would seem to have already been answered by our Perfect Circle Speedostat. It is electrically driven and is the control device offered on 1958 Chrysler and Imperial automobiles under the name of Auto-Pilot. Next year, it will be optional equipment on one of the other Big Three makes.

—JOHN SENN
Perfect Circle Corp
Hagerstown, Ind.

Personnel Men—Closed-minded Extroverts

To the Editor:

"Can you Spot a Creative Engineer?" (June 16, p 30), should be listed as "required reading" for all personnel men, and particularly those whose chief business is that of interviewing prospective engineers and designers. Far too few personnel men have even a "nodding" acquaintance with engineering requirements, and haven't the foggiest notion how an engineer or a designer works or thinks, or what makes him tick. To most of them an engineer is just another member of the rapidly growing conglomeration of "hired help."

Almost without exception, the good engineers and creative designers are introverts. On the other hand, most personnel men are extroverts. They have to be in order to work, as they do, with all sorts of people. There is no brand of intolerance as strong as that of the introvert for the extrovert, and vice versa. That fact does more to breed an atmosphere of misunderstanding, mutual distrust and dislike between the two groups than any other one thing. More personnel men with an engineering education, or better yet, more personnel men who have actually practiced engineering for a few years, would well serve to alleviate a lot of this unpleasantness.

I passed my copy of *PE* to a personnel man of my acquaintance and asked him to read the article. He called me a couple of days later, and was very much upset. As a matter of fact, he "blew his stack."

"What in the hell does this fellow Lichtgarn think he's going to accomplish," he said, "by making us personnel people look like a lot of idiots who don't know our jobs?" He went on to preach the personnel man's gospel that everybody knows that a man who likes to work alone is antisocial, and an antisocial man is no good for business. Also, any man with any common sense knows that a man who changes jobs more often than twice in a lifetime is a job-hopper whose presence in an organization always causes trouble. His inherent chronic dissatisfaction is contagious, and pretty soon everybody in the place becomes infected and wants to go hunting greener pastures.

As long as some personnel men hold opinions of that sort there is bound to be an atmosphere of dislike and distrust, even out-and-out hostility, between engineers and personnel men.

—LARRY COBURN
Akron, Ohio

MOLY NEWS

CLIMAX MOLYBDENUM CO. DIVISION • AMERICAN METAL CLIMAX, INC.

Climax Develops an Extremely Tough, Abrasion-resistant Chrome-Moly White Iron

New Alloy Proves Superior in Erosive Applications

A new martensitic white iron has proved exceptionally tough and resistant to abrasion. It's called Alloy 42. Its excellent combination of properties are related to its structure — which consists of hard chrome-moly carbides favorably distributed in a matrix of martensite plus retained austenite.

Tests indicate Alloy 42 is especially economical for parts subject to erosive wear: sand pumps, flotation impellers, sand classifier wear shoes, pug mill blades, brick mold liners and chute liners.

For example, heat-treated Alloy 42 impellers in a 5" sand pump handling coarsely ground taconite ore have already lasted over 1,000 hours. Previous impellers made of a 4.5% Ni, 1.5% Cr type of martensitic iron lasted only 350 to 400 hours.

Because of its toughness, Alloy 42 can also be used where moderate impacts would cause low alloy types of white iron to break or spall. And it may prove more economical than the soft rubber parts or linings now used in various abrasive applications. Its resistance to tearing by tramp coarse materials and chemical attacks by oils and other organic compounds is an obvious advantage.

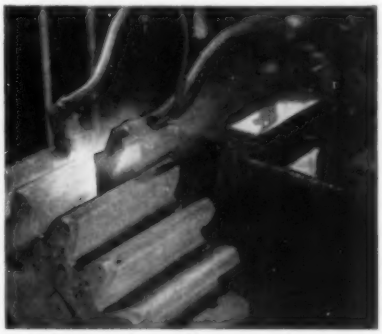
The recommended composition range is: Carbon 3.00-3.50%; Silicon 0.30-0.60; Manganese 0.60-0.90; Chromium 15.0-18.0; Molybdenum 2.75-3.25.

A Climax bulletin on Alloy 42 discusses melting and casting, molds and shrinkage, heat treatment, structure, physical properties, machinability, welding and cutting. *For a free copy, circle #1 on the coupon.*

Heat Treating Improves the Wear Resistance of Gray Iron

Heat treating can improve many of the properties of gray iron, particularly resistance to wear. Wear resistance in quenched-and-tempered gray iron is many times greater than that of pearlitic irons. With cams and similar parts, hot quenching provides better wear resistance than quenching and hardening to the same hardness. Surface hardening is frequently selected for gray iron because it locally improves wear resistance with minimum distortion.

Why Moly Iron Bulletin #6 contains valuable information on surface hardening, annealing and stress-relieving molybdenum-alloyed irons. This bulletin gives examples of improvements obtained by heat treating gears, cable drums, pump-ring castings, tappets, valve guides and machine tool ways.



Flame hardening the teeth on a sprocket improves wear resistance with minimum distortion.

*For a free copy of **"Why Moly Iron Bulletin #6,"** circle #2 on the coupon.*

Tempering Low-Alloy Creep-Resistant Steels

A recent British paper discusses the roles of chromium, molybdenum and vanadium in low-alloy steels with high creep strength. The relation between creep properties, microstructure changes and carbide composition is given special attention.

*For a copy of **"The Tempering of Low-alloy Creep-resistant Steels Containing Chromium, Molybdenum and Vanadium"** by E. Smith and J. Nutting, circle #6.*

Moly Helps High Alloys Fight Corrosive Attacks

Highly alloyed materials are playing a greater part in combating corrosion. A current paper on these alloys considers the molybdenum-bearing alloys at length and also discusses cobalt-base alloys and silicon-bearing alloys.

*For copies of this paper, **"High Alloys to Combat Corrosion"** by E. D. Weisert, circle #7.*

Thermenol Shows Excellent Resistance to Heat, Corrosion

Thermenol, an iron-aluminum-molybdenum magnetic alloy, compares favorably with other high-temperature materials, and in some cases promises even better service. For unlike many alloys, it doesn't lose tensile strength rapidly up to 1200 F. It also has excellent resistance to oxidizing and sulfur-bearing atmospheres at high temperatures.

*For a copy of **"Iron-aluminum Magnetic Alloy Has Excellent Heat Resistance,"** circle #8.*

Moly in Nickel-base Casting Alloys Improves High Temperature Service

Molybdenum is helping at least two nickel-base alloys to work more effectively in high temperature applications. One of the alloys, with 5% Mo, combines good castability with very good creep strength at temperatures up to 1800 F (much better than that of moly-free alloys). The second, with 10% Mo, shows high resistance to thermal shock.

*For free copies of **"Some Properties of Nickel-base Casting Alloys for High-temperature Service"** by D. R. Wood and J. F. Gregg, circle #3.*

Cast Steels Studied at Low Temperatures

The British Steel Castings Research Association has completed new studies on the effect of melting practice, composition and treatment of steel castings. Five of the seven alloy steels investigated contained molybdenum. The benefits of using molybdenum in low alloy steel castings for low temperature service are clearly shown in comparisons of 1.5% Mn and 1.5% Mn-Mo.

*For reprints of **"The Low-temperature Impact Properties of Cast Steel"** by W. J. Jackson and G. M. Michie, circle #4.*

New Data Available on Low Carbon Bainitic Steels

Studies have been made on new steels based on boron-0.5% Mo. Tensile strengths up to 180,000 psi can now be obtained within the bainitic range with a wide range of cooling rates. Thus these low-carbon bainitic steels offer a good combination of mechanical properties as-rolled or as-air-cooled. These properties can be obtained in large sections because hardenability is high. Good welding properties and tempering characteristics make the steels especially suitable as high-strength weldable steels, forgings, die blocks, etc.

*For copies of **"Low-carbon Bainitic Steels"** by K. J. Irvine and F. B. Pickering, circle #5.*

Climax Molybdenum Co. Division, Dept. 2
American Metal Climax, Inc.
500 Fifth Avenue, New York 36, N. Y.

I'd like more information on:
1 2 3 4 5 6 7 8

Name_____
Company_____
Street_____
City_____ State_____

for instruments, timing devices,
control apparatus and similar applications

USE BODINE K-2 MOTORS

...they're small, only 2⅜" high
instantly reversible
totally enclosed
1/2000 to 1/500 horsepower

This Bodine Type K-2, ball bearing motor is among the smallest distributed-wound motors manufactured today. It's ideal for those "hard-to-get-at and out-of-the-way" installations because of its small size and extreme dependability. It delivers considerably more power than "clock-type" motors, and it's particularly well-suited for powering instruments, timers, controls . . . and similar equipment requiring relatively low output, and steady, trouble-free service.

Bodine K-2 motors are available synchronous or nonsynchronous . . . and with or without speed reducers. Speed reducer models have high starting torque of not less than 150% of full load torque at room temperature.

Write for bulletin 1024A,
"Bodine Type K-2 Motors"... bulletin 1023B,
"Bodine Parallel Shaft Speed Reducer Motors"

BODINE ELECTRIC CO., 2260 W. OHIO ST., CHICAGO 12

BODINE
fractional / horsepower
MOTORS

BODINE

...the power behind the leading products

The Bodine line includes 265 different stock types and sizes ready for fast shipment.

...third of a series

How to make motors last longer

Careful maintenance is the best and least expensive way of getting dependable service and long life from your fractional horsepower electric motors. Here are maintenance suggestions:

Be sure loads do not lock on reducer motors. Provide a friction clutch if there is any possibility that the driven shaft may be locked. Such locking will quickly build up a tremendous force within the reducer gears . . . causing them to strip or break. If you must use a flywheel, attach it to an extended *high-speed* motor shaft, not a *low speed* shaft. If a flywheel is attached to a low-speed shaft, it tends to keep this shaft turning after the motor has stopped . . . with the same effect as locking the driven shaft.

Be sure your motor is properly rated for its job. If it is necessary to move your motor from one job to another . . . or to operate it continuously where previously you have been running it for short periods of time, be sure it is rated properly. For example, one type of motor is rated for intermittent duty because the temperature rise within the motor will not be excessive. If you put this same motor on a continuous duty application, there will be an excessive temperature rise which will burn out the motor . . . or at least deteriorate the insulation.

Free copies of article on temperature rise measurements available

Three of the fundamental methods for temperature rise determinations set up by the American Institute of Electrical Engineers are discussed in the latest issue of "The Motorgram," a bimonthly publication. Copies are available on request.

PERSPECTIVES

in design and development . . .

Japan: the Design Competitor with Problems

Midsummer 1958 found Japan's economy at a crossroads. Its remarkable recovery and development in the postwar period—probably equaled only by West Germany's—seems to be leveling off. Yet the Japanese believe the high rate of economic development which their country has experienced in the last decade must be maintained. (National income up an annual average rate of 11.4% since 1950—compared with 4% during the 1930s.)

Key to Japan's hopes are exports. Today they are triple what they were in 1950 ($2.858 billion in 1957). But Japan's chief problem is that there are no raw materials within the country to maintain the flow of these exports. Japan must import these raw materials, add a labor content, then export products to world markets at competitive prices. The world's best markets lie farthest from Japan and most of her present sources of raw materials are distant. (Political and economic difficulties have eliminated mainland China as a supplier and a market.) Japan's best customer today is the US, but Japan here runs a trade-balance deficit of a half billion dollars. To help reverse this trend, the Japanese—with considerable success—are pushing high-quality cameras, transistorized radios, and hope to get into such things as electronic computers.

Better design and higher efficiency in Japanese plants will play an increasing role in these attempts. The Japanese see themselves as more fitted than Western European and American manufacturers to meet the needs of the Afro-Asian developing economies. Furthermore, they believe their lower volume of mass production permits them to make the kinds of specialized products these countries need. In autos, for example, Japanese feel that the car built to stand rough treatment by the semiskilled Japanese driver and the poor roads of his islands, suits the needs of Burmese highways better than a US- or European-built machine. Nippon hopes to apply this general principle to such things as power-generating equipment, textile machinery, and metalworking tools.

In the past, Japanese designers have failed to provide this leadership in export-market designing for two reasons: Markets have not existed; a slavish devotion to copying the advanced techniques of the West.

Indirect Aid from the US

However, there are signs of change. Economic-development programs of such countries as India and Pakistan offer hope of new markets for Japanese products. US aid programs for the Middle East and Southeast Asia will inevitably benefit Japanese exporters—though indirectly.

Note also a new attitude toward design developing in Japan. It has many components. Partly it is simply the psychological attitude of younger Japanese businessmen, ashamed of their reputation for pirating design. *(PE—July 21, p 20)* There is also increasing awareness that this nation has a cultural tradition in the plastic arts which will in time be used, most designers believe, for machinery and industrial-appearance design.

Simultaneously the Japanese are trying to improve their manufacturing methods. No factory owner in the world is more aware of the importance of up-to-date machinery than is the average Japanese industrialist. But medium- and small-scale Japanese industry does not have a capital structure that permits investment in costly plant renovation. And Japanese manufacturers are finding that unskilled labor is not "cheap" in long-term competition. All this points to an increasing interest in new theories of machine design and automation. —PAUL ANDERSON

Engine, Boiler, Turbine, and Control Manufacturers specify . . .

HEIM *Unibal*®

SPHERICAL BEARING ROD ENDS

For changing lateral motion or power to vertical or transverse motion, many rod assembly designs are used. Some of the factors which influence the design of a push-pull rod assembly are:

Load — compression, tension, or vibration.

Length — as it affects column strength.

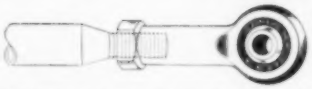
Space allotted — envelope dimensions.

End fittings — method of attachment to adjacent operating units.

The majority of rods used in linkages have male threaded ends to which an adjustable rod end bearing is attached. The rods may also be female threaded with a Heim Unibal male rod end bearing. This type of assembly presents some advantages in that the smallest diameter of the Unibal may be closer to the point of attachment.

See illustration of both methods.

Female threaded rod with adjustable male unibal rod end bearing



Male threaded rod with adjustable female unibal rod end bearing

Because of the universal motion of the single ball, the Heim Unibal Bearing has the ability to correct shaft or linkage misalignment in all directions.

Assembly is quick and simple. Greater load ratings for substantially smaller dimensions are attained.

Many leading manufacturers of equipment requiring push-pull linkages depend on Heim Unibal.

Call or write now for engineering advice and complete catalog. Also list of distributors and representatives.

THE HEIM COMPANY FAIRFIELD, CONN.

For Prompt Service, contact any one of our more than 150 distributing points across the country.

Product Engineering **HORIZONS**

September 1, 1958

Standardized BRAIN?

Once, long ago, when the railroads were young, each locomotive had a name. That was proper, because it was built to an individual design. For most of a century, the railroads continued to make their own designs for steam locomotives, ordering only a few of each type. Builders came up with their own special designs, too. So every repair job was individual tailoring.

Then General Motors introduced its diesel locomotive, made in standard sizes, so that standard parts could be bought at low cost and stocked. The next step was to offer repair service and scheduled major maintenance at a few strategic locations, where any railroad could send its engines.

The diesel caught on. So did the standard design and service formula. They saved money, so despite the cries of sentimental railroad buffs, the roundhouse disappeared, and with it the romantic steam locomotive and its plaintive whistle. Now we have standardized locomotives, stopping at service stations.

Now this is progress, and in many ways it's a good thing. But there are those who say this philosophy should displace all others—we should eliminate one-of-a-kind craftsmen, hole-in-the-wall retailers, horse-and-buggy manufacturers, door-to-door salesmen. "Let's cut off the inefficient and vulnerable parts, the specialties, and have grand and glorious standardization," say they.

It's a sound philosophy, but somehow it doesn't work. There's always a place for the corner grocer who stays open when the supermarket bows to labor demands and closes, the one-man shop that will make what you want because its owner is more interested in making things than making money, the craftsman who puts a special twist or polish on his work, the service man who isn't above baling wire when the standard part isn't in stock or the whole new replacement assembly is expensive.

They're unprogressive, these people, and they probably couldn't survive if they were forced to standardize and join the mob. But, then, neither could you. You have an unprogressive, individualistic streak somewhere, even if it's only for wearing long underwear, and it's that streak that makes you a personality despite regimentation in most things.

The fundamental point is that the "average" is not an actuality; it's a mathematical concept like minus numbers or infinity. There must be some sub-par and some over-par units so the average can be drawn. There must be some special design, there must be some too advanced and some not advanced enough, some for mass production and some for job-lot or one-of-a-kind.

Tomorrow's standards will not be today's. The only way to develop new, higher standards is for somebody to get away from the average, to be a bull-headed individualist. He can be wrong, very wrong, but at least he "gives people to think." And thinking may clear the standardized cobwebs from a standardized brain.

"Haus der Konstrukteure" is DEMAG's technical center at Duisberg, Germany. Here more than 1000 engineers and technical staff design mechanical plant and equipment for steel works all over the world.

Engineering in ... a quick look

While visiting Product Engineering field offices in major European cities, Chief Editor Tangerman also had opportunity to meet and talk with engineers in London, Hannover, Zurich, Baden, Milan, Turin and Stockholm. Here is a digest of current opinion he gathered on training, advancement, availability and use of engineers, design and R & D organization.

E. J. TANGERMAN, *Editor*

COMPANIES INTERVIEWED

ENGLAND
- **The Institution of Engineering Designers**, London

GERMANY
- **Siemens & Halske**, Munich, communications-equipment division of **Siemens-Schuckertwerke**, power equipment
- **DEMAG Aktiengesellschaft**, Duisberg, steel-mill, handling

SWITZERLAND
- **MAAG**, Zurich, gear-making machinery, gears
- **Brown-Boveri AG**, Baden, electrical and hydraulic machinery
- **Zurich Federal Technical University**

ITALY
- **Innocenti**, Milan, scooters, machine tools, steel-mill equipt
- **Fiat**, Turin, automobiles, appliances, aircraft

SWEDEN
- **Telefonaktiebolaget L. M. Ericcson**, Stockholm, telephones

Basic differences—and basic similarities—in the European and American approaches to design are reflected even in the limited survey I made in England, Germany, Switzerland, Sweden and Italy. Interviews with engineers of major companies in these countries brought out many variations—from country to country, as well as company to company.

As would be expected, relatively few companies are willing to discuss research and development projects or design developments not yet announced, yet I toured several R & D labs. I found the same variations in "information policy" there as one does here: in some cases extreme detail, in others none.

In general, the organization for releasing information is not nearly so elaborate as it is in the US; I met no advertising or public-relations men, no agency contact men. But in three companies I was guided by a man who has no actual US equivalent—an engineer on the

REPRINTED—Circle E 40, inside back cover

EUROPE

executive staff whose prime function is to escort visiting engineers, who is thoroughly familiar with all departments—a linguist, a connoisseur of foods and wines, but above all an "engineer's engineer." This insures maximum return to the visitor for the time spent, both in the plant and in the particular city.

The New Man

Training of engineers is a problem not unique to the US. Graduates of European colleges also must be trained for their work, and the procedure is much the same as here. In many cases, there has been the same problem of shortages of graduates in recent years, although the distribution of available engineering talent to particular jobs is much more advanced. At Siemens & Halske, for example, a ratio of three diploma engineers to five practical engineers is maintained, and there is extensive use of technicians to assist them. (Technical draftsmen in Germany are the graduates of a 3-year apprentice course, may be men or women.) General practice is to support each diploma engineer with a staff of less highly trained people to handle details. At DEMAG, there is one engineer for each four employees, a rather high ratio.

There has been an engineer shortage in Germany and Switzerland, but not in Italy or Sweden. Executives in Italy feel the reason it did not develop so soon there is that the release of engineers from military production gave a surplus that has only now been absorbed. (This factor has been very important in the US as well—recall the far-reaching effect of cancellation of the North American contract on the Navajo missile; it caused layoffs both in California and New Jersey.) "Shortage" is of course a relative term; there has been difficulty in obtaining sufficient numbers of suitably trained men (*PE—Sept. 16 '57, p 61, Oct. 14, pp. 61, 113*). The evidence is that in Europe the larger companies have had less problem with shortage than the small; they've raided to get good men. As a result, the small company is forced to pay a premium for engineers and there has been much moving around of younger engineers. Some non-pirating agreements have been made (how familiar!), and engineers' salaries have shown some improvement. But they are, of course, still small by our standards.

Perhaps a fundamental point here is that Europe has never really had enough engineers; Wars and emigration have taken their toll, and as one manager said, "Europe can't afford to train enough all-around engineers, hence we use many specialists. Experience has too much weight here, not enough in the US." Salary comparisons tend to bear him out.

Starting rates in Germany for diploma engineers are 500 to 600 Reichsmarks/month—$140 to $150. This will perhaps be doubled in five years and reach $400 a month in 10 years. Thus the range appears to be wider than in the US, where the 10-year man is lucky to double his starting salary. For comparison, a German high-school teacher gets 1700 marks top ($425/mo).

In Germany, larger companies train suitable men of their own as practical engineers, thus meeting the problem of shortages. In Switzerland, a well-established system for producing technicians has eased the problem. Zurich Federal Technical University (one of two in Switzerland), for example, is the source of most engineers for MAAG in Zurich, but "*technicums*" (technicians) are provided by schools in Winterthur, Biel and Bergdorff. Others come from night schools (are called "night *technicums*") and get practically the same salaries as day graduates. Brown-Boveri has operated similarly, but has imported engineers from Germany and Italy as well. (It must be realized that distances in Europe are relatively short; Brown-Boveri is currently employing 3500 foreign workers—male and female—from Germany, Austria and Italy, most of whom commute over the border daily. Some barracks are available for workers during the week. There are also, incidentally, company apartments available to workers, with three or four rooms renting for around $16 to $18 per month. (I must mention that the quick way used by Brown-Boveri officials to differentiate nationalities of women workers is to look at their lips—Italian girls wear lipstick.)

Innocenti, in Italy, has no official or organized way of training student engineers, but breaks them in much as any other employe would be. It is also forced to train engineers of its own, because output of student engineers in Italy is not sufficiently large. This company, which produces machine tools, steel-mill machinery, and 500 to 600 Lambretta scooters a day, has several hundred engineers. The Italian air force has sponsored special courses in electronics and in iron and

EUROPE . . .

Fiat's G91 fighter was the winner in the NATO design competition, can operate on grass or semi-airfields with short takeoff and landing requirements. It has a Bristol Orpheus turbojet capable of 4850-lb thrust, is being built for most NATO members.

steel to which Innocenti has sent men. The company also has engineer training courses and human-relations courses for executives.

Engineer Training

Advanced training is apparently not so formal or organized as it is in the US but it does exist, both on in-plant and cooperative bases. Innocenti, which builds Clearing presses and Mesta machines (both American) under license, has sent two engineers to Clearing, five to Mesta and several to Vickers for specialized training. It has cooperated with Fiat on electronic training, sent men to a state institute for management training. Brown-Boveri has set up specialists or hobbyists among its engineers to give specialty training courses to fellow engineers during winter months. The Swiss Federal Government also supports schools, including one for foreman training at Winterthur. (Brown-Boveri also has a very elaborate 4-year apprentice-training program.)

Siemens-Halske, communications-equipment division of the still-larger Siemens-Schuckertwerke which makes power equipment, is a large complex similar to GE or Westinghouse here. Its training facilities are similarly complex. It does a great deal of training of its own engineers—even to the extent of providing its own courses taught by S-H experts, with special titles for the engineers who take them. Major attention is given to placement; the engineering-college graduate has a 1- or 2-year apprentice course and is allowed to try various departments before he selects his own specialty. This is the result of the fact that S-H hires some 500 new engineers a year, and Siemens-Schuckert another 1000.

These numbers make it possible also for the company to aid the engineer (six semesters of basics) to go on with night study to win his diploma (8 or 10 semesters), and from that to his doctorate. There is an interesting sidelight to this latter degree; S-H has frequently hired a university professor to supervise needed research, with the proviso that an S-H diploma engineer do the actual work at the plant, with credit towards his doctorate. The company has on occasion also supported a man in outside daytime study where direct value to the company was evident. Groups of engineers are drawn from various departments for management training also—it is a cardinal principle to promote from within.

Management by Engineers

Management of European plants producing capital goods is much more likely to be made up of engineers than it is in the US, because of the greater prestige attached there to such training. Thus while Phillips (Holland) and AEG are heavily sales-oriented because of their consumer-goods interests, Siemens is heavily engineer-oriented. This results in the department set up with an engineer as manager and a personnel specialist as his assistant, instead of the opposite arrangement found in the US. It also results in provision for the engineer who does not want to manage—he becomes a "scientific consultant," with roughly the same financial and social recognition as a manager.

At MAAG, in Switzerland, *all* department heads are engineers (mostly from Zurich University, by coincidence), even in sales, because so much engineering is involved in gear machinery. The same reasoning applies at Ericcson in Sweden, because of the technology behind the telephone, and in the USSR, because of the necessity of providing so much basic engineering with products. The effect seems to be greater pride in producing a quality product, with emphasis on excellent detailing rather than on profit margin.

Cherchez la Femme

Some 30% of Soviet engineers are said to be women, as compared with 51% of the enrollment at Moscow

Research at Innocenti, Milan, is centered in this new building, fully equipped with labs, drafting rooms, an extensive library and model shop.

University (emphasis on physical sciences) and 51% of the general population. As nearly as I could observe while in the USSR, no distinctions were made between the sexes as to prerogatives, income, assignments, or other factors, although major executives in engineering were principally men. Has this had any effect on practices in Western Europe, where traditionally women walk a step or two behind men? I asked the question in several countries. The answer in Germany was a uniform and firm "No!" Women are still without portfolio in engineering.

There were no women in engineering in Switzerland, Italy, or Sweden either, and the attitude was generally that this is no career for a woman. This point of view is, incidentally, a quite common one in the US as well. For the last 30 years, the woman engineering student has been disregarded—if not mistreated—by her male colleagues, and the woman engineer in industry frequently has a comparatively rough time.

In the USSR, I met a number of woman engineers, and as nearly as I could discern, no distinctions were made. Four of five department-head engineers to whom I talked at the Polytechnical Museum were women; all spoke some English. I saw one or two elsewhere, as well, plus countless women working side by side with men, on the same jobs. There were female streetsweepers, painters, laborers, craftsmen, machinists, as well as machine operators.

It seems strange and impractical of the West to restrict women in engineering so arbitrarily under the circumstances. Both in America, where the lady goes first, and in Europe, where she dutifully follows a man, we have restrictions; but in Russia she seems to walk abreast as the posters show her.

R & D Setups

Europe is separating its design engineering and R & D setups just as we are, and like us is not certain whether engineers should be grouped or subdivided by plant. MAAG, for example, has just split off its R & D group. This work was formerly based almost entirely on customer experience, and was an informal process among designers and department managers. Now there is a technical manager, with an electrical and electronic engineer, doing R & D, just as there is a metallurgist doing the theory in metals while a practical heat treater heads the heat-treating department.

MAAG and SIP, both machine-tool builders, do all their own research, practically speaking. Like most European plants, they don't want their projects noised about. They do not use colleges in research (except for such things as special tests on fatigue of gears at the University of Zurich), but do use lab facilities of larger companies when necessary—for example, Escher-Wyss for tensile, compression and impact tests, because E-W has the needed equipment.

At Brown-Boveri, design is subdivided into electrical and thermal, each with its own engineering manager. However, a combined research lab works with both, although each has its own laboratory as well, just as each plant does. The central lab takes up broad problems, just as a central "Fabrikstudieren Bureau" provides manufacturing answers to broad problems. Design reports are distributed on an irregular basis, but there are monthly meetings of executives to learn of new products, reports among departments every two months, and regular gatherings in a local theatre at which employes are informed of developments.

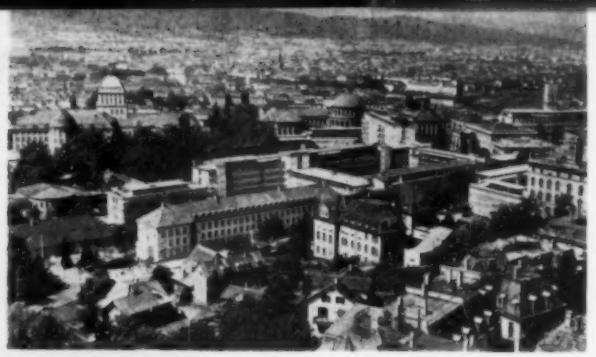
In the light of US reports that European plants do a great deal of research, I was surprised to find that often the amount of development work varies inversely with the current sales picture. If current products are selling well, there is no pressure to develop new ones. This is, I suppose, a reflection of the relatively smaller amounts of capital available for operations in general. No money is spent where it isn't vital. It should be remembered, however that European plants are not nearly as specialized as American, because they do not enjoy similar mass markets. There is thus a great deal of applied research and detail designing under way all the time in capital-goods plants, to take care of the varied customers.

Each department at DEMAG has its own twin engineering setup—for design and R & D—and there is a technical center at Duisberg containing 1000 engineers which is departmentalized as well. Thus most of the company's engineers are physically together, but they still report to separate departments. This physical nearness does, however, simplify intercommunication, and the path to interchange of data is further simplified by printing and distributing special reports and by a monthly *DEMAG News*.

DEMAG also has a rather unique organization called the "Technical Scientific Advisory Council," which meets about four times a year at the call of the general manager to review accumulated research and study projects. It contains about 15 men, about half-and-half theoretical and practical. Its peculiarity is that some of its members are professors from leading universities, some are leading men of customer plants.

Siemens-Halske is the exception to the pattern; its R & D and product design, once separate, were recently combined. Research teams are assembled for each project, and a team from one department may work with one from another on a similar problem. New developments and discoveries are detailed in written reports circulated to all departments—another assurance of intercommunication. Research can be done outside only with special permission. Currently, about 10% of all projects are

EUROPE . . .



Zurich University is one of two major sources for Swiss diploma engineers. It has very modern engineering facilities—even the PRODUCT ENGINEERING Zurich editor, a graduate, has his own small lab for work he is doing on instruments.

Martinsberg is the name given Brown-Boveri's employe clubhouse in Baden, Switzerland, which serves 1350 employes noontime meals simultaneously, also has a lending library, reading rooms, meeting rooms, and "do-it-yourself" facilities in wide variety. It was built in 1953.

basic research; in semiconductors it runs as high as 50% because of the newness of this field.

S-H, incidentally, has its own special industrial-design group. It also has a separate group—the Technische Abteilung ("Technical Dept")—for cost and quality control, redesign and appearance, which handles conversion of a prototype design to quantity production.

Innocenti has all R & D centralized in its "research center"—even nuclear power. Programs come from management and are developed in collaboration with the technical staff in the sponsoring department. Outside consultant specialists may be brought in to handle research for specialized products (one on pipe, another on milling machines, etc.) Much work has been done here on powder metallurgy, better cast irons and like subjects, although suppliers are asked to provide research results if they are competent.

The company has two classes of product: one mechanical, the other, automotive. In the automotive category is the Lambretta scooter, currently in production at 500 to 600 a day, six days a week. It sells for the equivalent of $250 in Italy, about a fourth the cost of a small car like the Fiat 600. A plant is, however, being built to produce the German Goggomobile, a very small car. One engineer pointed out that public tastes change: In Switzerland, the trend is from bicycle to scooter, in Italy from scooter to small car.

The other field of R & D at Innocenti is mechanical, encompassing Clearing presses, ingot and rolling mills, drawing rolls, pipe-rolling and piercing machines, and boring and milling machines. A great amount of work must be done in this area because of variations in design and working conditions for the product. (There were currently in production three big blooming mills, two for Italy, one for Sweden; a million-ton steel plant for Venezuela, enlarged from a 500,000-ton pipe shop, "the most modern in the world"; and several other projects.)

Rinoscenti, big Milan department store, is incidentally, one of two European stores that maintain industrial-design setups. They study to improve products they sell, passing their findings on to makers who are often too small to support such an activity.

The largest R & D laboratories I saw were those of Fiat, in Turin, where Fiat automobiles, home appliances, and the NATO jet fighter are made. The labs include extensive test setups for auto parts, fuels, finishes and the like, as well as research facilities, and covers an area of 54,000 sq ft. It not only does extensive work on its own, but also supervises and coordinates the work of labs in the various production departments.

Organization is vertical for services, horizontal on development and research. It includes two materials-study centers, one for metals, one for plastics, in which are grouped chemists, physicists, metallurgical and electrical engineers drawn from the various plants. Research is heavily in the applied category, and is done under direct supervision of a vice-director.

Subdivisions of the laboratories are:

1. **Metallurgical:** metallographic and mechanical tests. Pilot plants are provided for melting (including vacuum), powder metallurgy, drop hammer, press, rolling mill,

and heat treatment. Temperature equipment is available from below zero to 2000 C.

2. **Physical-Mechanical:** labs for physics of metals, wear and friction, thermodynamics, fatigue (both specimens and components), fatigue on full-size major aircraft components, creep, and metal workability.

3. **Technological:** practical applications and working processes. One lab for physical tests on polymers and for mechanical, thermal and optical tests on rubbers, plastics, paints, adhesives and fabrics; another for small-scale production of plastics, rubber, resins and paints; another for artificial aging, environmental and fatigue tests.

4. **Electrochemical:** pilot plants for study of galvanic processes, environmental and mechanical stress on coatings, etc.

5. **Organic and Inorganic Chemistry:** absorption spectrometry in both infrared and ultraviolet ranges; lab for aviation fuels and lubricants. Special work has been done on emission spectrography.

6. **Electrical Experiments:** testroom for electromechanical units, automotive and aviation accessories, lighting devices, and home appliances; acoustic room for noise tests.

Equipment at Fiat is a surprising assortment of European and American types, like Baldwin and Amsler, with a goodly number of units Fiat developed for special tests.

Universities

In sharp contrast to American practice, relatively few European companies use universities for basic or applied research, although they may use professors as consultants or advisers on occasion. Also, in some cases, the company utilizes test equipment of the university on a fee basis. An interesting exception to this is a recently developed program of management consulting at the State University of Zurich. There the Industrial Engineering Department now includes only one professor and a couple of assistants who teach classes, but 35 men engaged entirely in consulting work for industry, principally on newer American ideas in work study, plant engineering, materials and production control. There is no consulting in either market research or design.

Engineers in Europe appear to have a high regard for the universities, and respect for their opinions, but the feeling of remoteness and "theory-pushing" seems to be even more pronounced there than here. There is very little contact in most cases; each organization has its own orbit.

Class Distinction

With the respect that the engineer receives in Europe, there is also a great deal of class distinction. The engineer moves in a higher circle than the shop man; they meet but do not fraternize. This distinction appears to be in process of breaking down, particularly in the more democratic countries. This also leads to some paternalism —provision of company-sponsored facilities for medical care, rest, recreation, and education. There is, in addition, evidence of adoption of such principles as mechanized handling and safety, although neither is nearly as far developed as in the US.

The Inner Man

Food is important to Europeans. They appreciate and enjoy it, spend time in preparing, serving and eating it. The engineer is often also an expert on foods. For instance, in Baden, Switzerland, we ate at the Spa, with careful choice of wines and liquors. In Turin, we were given a wine, a cheese and a pear that blend perfectly, selected by our host, Fiat's R & D chief. In Moscow, the engineers provided a choice of vintages. And so on for Germany, France and Sweden.

This attention extends into in-plant feeding. Innocenti and Fiat provide a 3-course meal for workers at 10 lire (6 cents), far below cost of about 200 lire, which is the Olivetti price. At Brown-Boveri, a 1-plate meal is provided for 1.6 francs (about 40¢), and a 2-plate meal (for engineers, dept supervisors, etc) with tablecloth for 2 fr 20 (about 60¢). This is done in the "Martinsberg," a huge employe clubhouse opened in 1953. It has a library and reading rooms, recreational and sports facilities, sewing, woodworking and art rooms, as well as a main dining room that can seat 1500 people. Each worker has his own reserved seat, can order his drink (usually cider or grapefruit juice, although beer and wine are available) in advance. Soup, potatoes and vegetables are on the table, and his meat portion is served individually. Some recreational facilities are advisable because 1½ hr are allowed for lunch (really dinner there), so the rest of the 13,600 employes can go home to eat the major meal of the day.

At Ericcson in Sweden, the executive dining room is like one of our better ones, but there is in addition a separate coffee lounge with tables and comfortable armchairs. This is all part of the greater formality and courtesy evident in Europe. Engineers there are much less brusque and direct, much more inclined to relax by discussing art, music or other interests during off-duty hours. Their homes and offices are two very separate lives; apparently they neither take work home nor bring home problems to work.

Rush, Rush, Rush

Nowhere is the tendency of Americans—and more particularly the New Yorker—to rush more evident than in Europe. We tend to "hurry somewhere to sit down," while the European is comparatively deliberate. He is, as a result, much less likely to develop ulcers, but he aggravates ours. I was charging upstairs to the lunchroom at ENIMS one day in Moscow, when the chief design engineer said: "Why do you hurry so? We go only to dinner!" He was right—we were on our way to the long "dinner hour" of the European, a leisurely 1½ to 2 hours.

There is little evidence of rushing anywhere in European plants. Things are done at a slower pace, whether they be interviews or shop operations, except when the latter are timed by a conveyor or automatic machine. And in the case of shop operations particularly, they are done with more care and attention; the pride of workmanship is more generally evident.

REPRINT of this article can be obtained for your reference file by checking No. E40 on one of the Reader Service cards inside back cover. For other reprints available see "Current Reprints" listing in this issue on page 79.

Sir Henry Tizard, giving his Presidential Address to the British Association in 1947, said, "We need, not so much more scientific research, as more ability to make use of existing research." And later, "Science may make many things possible, but it does not necessarily make them happen."

engineering design

THE BACKGROUND AND BASIS OF CONTEMPORARY LIFE

HUGH CLAUSEN, O.B.E., I.S.O., B.Sc.(Eng.)

Satellite and missile failures are not caused by inadequate science but by poor design. Engineers are just as guilty as the general public when they neglect this vital aspect of today's industrial scene. This article, condensed from the 1958 Lord Westwood Memorial Lecture before the Institution of Engineering Designers in London, reminds us that our entire civilization may be the loser if young engineers are permitted to by-pass the drawing board in their rush for "success."

Engineering—in the broad sense—is the foundation of all industries and most human activities. Wherever one starts, whether it be silk stockings or shipbuilding, microscopes or motor lorries, we are back, in one or two stages, to the design of the machine tools used, the basic engineering on which our civilization is grounded.

The man of classical or literary education and culture cannot dismiss engineering as dry, materialistic, technical and a non-essential ingredient of a high civilization. Leonardo da Vinci advertised himself as an engineer, but there is no definite line of demarcation between his engineering drawings and his most highly developed examples of what we now call Art.

In our present age, we seem to have specifically excluded engineering matters from what is known as culture. Our education, our civilization, our culture and what is perhaps more telling, our national economy and prosperity, are the poorer as a direct consequence.

The Missing Designation

There seems to be a word missing in our language to express what is meant by engineering design. In England the word "Constructor" is limited in its application to the man responsible for the design and construction of ships and, latterly, aircraft. In Germany the word "Konstrukteur" covers a much wider field. The Konstrukteur is the man in any form of engineering activity who is responsible for the project as a whole, particularly the design. It implies that management and design cannot effectively be separated.

The lack in this country (England) of that word and its underlying idea may have led to the present situation where the word "designer" seems to mean no more than a draftsman capable of working on his own initiative. The drawing office is no longer the vital creative center around which the whole organization revolves.

Today the drawing office in many engineering concerns seems to have been pushed out on a limb instead of being in its proper place as part of the main trunk, with its roots seeking nourishment in the fields of research and its branches supplying the fruits of production. Drawing is the only medium of transfer from thought to material; nothing can exist unless it has been designed first. The place where quality is injected into the product is on the drawing board, and the instrument used for injecting it is a pencil.

Production or any other kind of engineering starts on the drawing board and depends on it throughout the whole process, whether as regards the product, the tools with which to make the product, or the tools to make the tools to make the product. The drawings are the only clear and unambiguous definition of what is going to be produced. I do not mean that the drawing

board is the only place where attention is needed. Quality may be applied there but missed in the product owing to faulty workmanship or manufacture; but if quality is not inherent in the drawings no other activity can make up for its absence there.

Yet even the scientific and technical press neglect the draftsman-designer. One sees articles dealing with the scientific, analytical or experimental aspects, illustrated by formulas, graphs and tables, perhaps even flow diagrams or key diagrams with gear ratios, but the next thing one sees is a photograph of the finished article, which tells you nothing—except what the thing looks like from the outside. Of the really difficult and important thing, the transformation of ideas into ironmongery, there is usually not a hint. It is apparently inferred that these things just happen by themselves.

What Is Engineering?

The four main parts of engineering are science, art, industry and finance (or commerce). Though divided, they overlap and interlock, they are mutually interdependent. At the moment, the balance between these four aspects seems to be rather upset. There has been great emphasis on management and productivity—broadly the last two aspects—and more recently there has been a drive to emphasize the importance of the "sciences," but a corresponding interest in the art—without which the other aspects cannot flourish—has not been noticeable. The art does not seem to have attracted the attention of men of corresponding quality and intellectual power to those on the scientific, industrial or financial sides.

This may be because design does not lend itself to either mathematical treatment or verbal expression. There seems to be an inevitable tendency for men of great intellectual power to concentrate on what can be expressed in literary, mathematical or symbolic terms, and to neglect what cannot be so expressed.

A good example of this tendency is the attention given by mathematicians to electromagnetic theory, structures or bridges, continuous beams and the like, and more recently, to servo-theory, that magnificent new stamping ground for the physicists. By comparison, activities like forging, rolling and pressing processes, or (perhaps the most important of all) machine-tool design, have been totally neglected by the scientist and left to be practiced as an art, usually at a rather lower intellectual level.

Our whole European civilization has suffered—and still suffers—from this attitude on the part of cultured humanity towards the craftsman, to whom words are almost useless as a medium of expression. Our standard educational pattern can be traced back via the older universities and the theological schools of the Middle Ages, to the classical philosophers, and particularly to Aristotle, who covered practically all available knowledge of his time. All knowledge, that is, which could be expressed in words or symbols. He neglected, as unworthy of serious consideration, the very highly developed technology of the time as the work of slaves, or at any rate beings of a lower order. This false attitude has continued to the present day.

Lord Hives, in the 1957 Lord Nuffield Paper, said, "The usual university graduate does not take kindly to drawing-office work; he looks for a more glamorous career in research, development, and testing. Industry is largely responsible; there is not sufficient encouragement to create first-class designers. The time is past for discussing the merits of a classical or scientific or technological education. Applied science is a part of our life. It is in our homes and in everything we eat or wear, and, above all, we enjoy it."

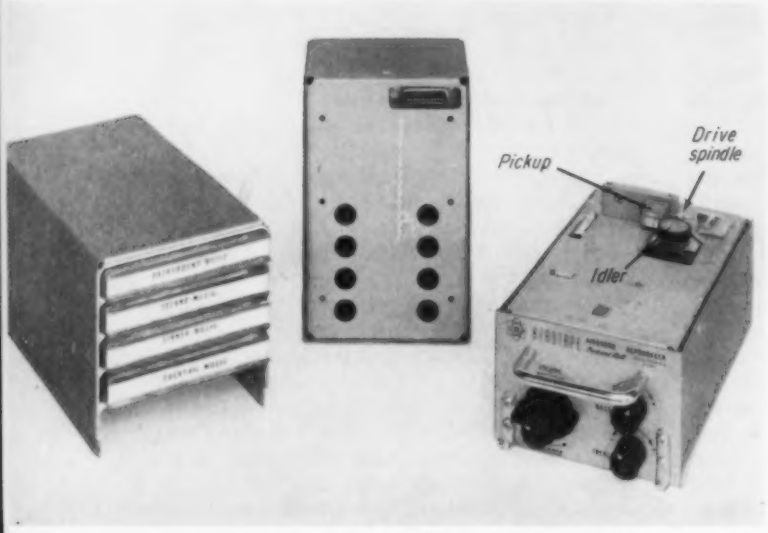
A generation of engineers is now growing up who not only cannot themselves draw but cannot teach, guide or inspire their draftsmen. In the Presidential Address to the Institution of Mechanical Engineers in 1952, Sir David Pye calls attention to "the yawning gap between the product of a university course and a qualified engineer."

Science has had much attention in recent years; press publicity as well as more serious thought. Its achievements, e.g. radar, television, and atomic energy in various forms, have insured this, but I doubt whether its debt to Engineering is fully realized and recognized. Industry too has had much attention with all the emphasis on "productivity! productivity!" without enough thought to exactly what it was going to produce. Finance has had even more attention and dominated the whole picture.

But technical competence is an essential part of higher managements. It is understandable that decision must be subject to the point of view of financial profit. But this is not the only consideration. The theory that higher financial management is all, and that creative talent can be hired and fired like unskilled labor is dangerous. There are just not enough able men to go round. The fault lies entirely with industry in not taking steps to select and train men for the future, and in offering much better rewards for managerial activities than for creative ones.

During my whole time in the engineering world—well over 50 years—there has been a steady drift of men of ability away from the design and creative aspects into finance, administration and management. The result has been a (relative) decline in the quality of the country's products. There has been no actual decline; with rare exceptions there has been a steady improvement all round. However, there are plenty of examples where other countries which formerly looked to us for guidance and example have improved so much faster that we now look to them to show us how to do it. This is inevitable unless the talent available is applied in the proper places. How very difficult it is to convince people who have little technical background or understanding that finance should be the servant of industry and not its master!

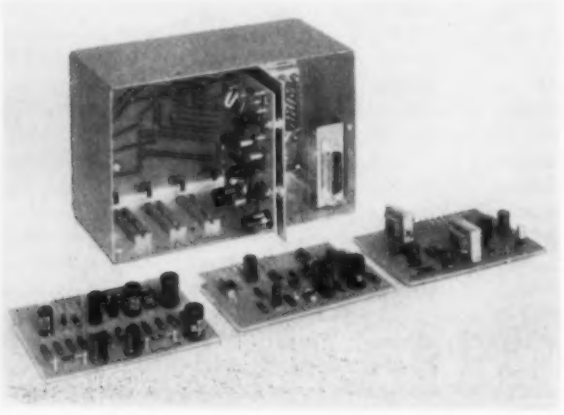
In England we need a much greater recognition of engineering as a major part of our contemporary culture; and in industry we need a better balance between the different aspects, to encourage engineering design to be conducted on the same intellectual level as the science. It must be recognized as an equal partner in industry and one of the most essential tools of management. We must endeavor to understand the language of design and recognize the importance of design ability as a major factor in our national survival. ■



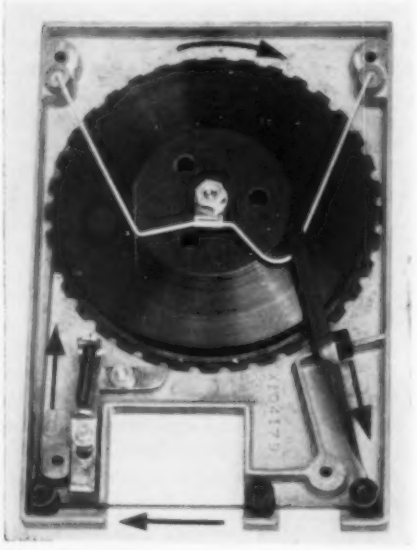
This Tape Recorder Rides Planes

Its single-reel tapes come in magazines allowing easy change for in-flight music or speech recording. Transistors and building-block construction reduce unit weight and simplify maintenance.

Designed originally for recording speech in military test applications, Aerotape is being adopted as a music reproducer for commercial jets—its 5 magazines of tape hold 3 hours 45 minutes of music, more than enough for average flight. Airline personnel can change tape in 5 seconds without rewinding reel. Produced by Packard-Bell Electronics Corp., Los Angeles.

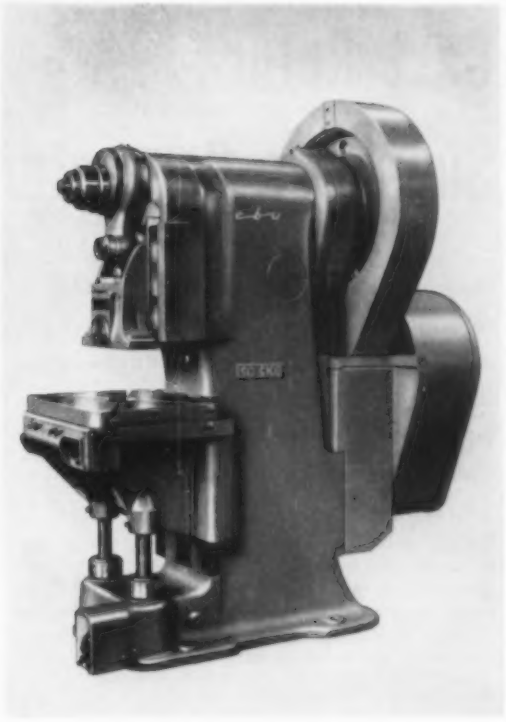


Modular construction . . .
breaks unit down to tape-storage rack, amplifier and tape-drive mechanism. Amplifier in box chassis has plugboard and four plug-in printed-circuit panels. Panels may be tested or replaced individually, simplifying inspection and maintenance. Single motor pulls tape across pickup head at 3.75 ips. Tape is held against polished metal drive-spindle by rubber-faced idler wheel. During magazine insertion, idler wheels drops into chassis, allowing tape to be positioned against drive spindle. Transistorized and miniaturized components reduce weight in keeping with aircraft practice. Entire unit, ready to play, weighs 15 lb.



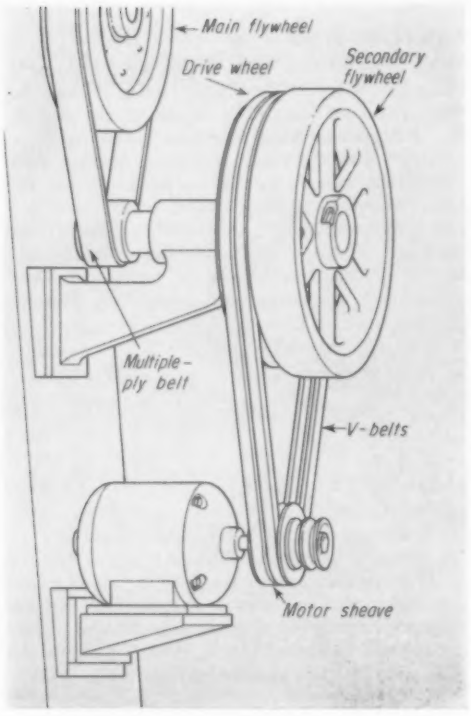
Plug-in connection . . .
on rear of recorder allows nesting it in standard communications equipment racks. Endless tape is pulled from center of reel and rewound on outer edge. Spring catch locks reel when not in playing position, assures constant tape tension.

Second Flywheel Gives DOUBLE-DUTY PRESS



No need to change speed of the motor—this belt-driven eccentric press can either blank or draw. The choice depends on whether one or both flywheels go along for the ride.

Added features are silent power transmission, and elimination of expensive helical or herringbone gears. Multiple-ply plastic belting and V-belts are used for all drives on the 50-ton press. It's produced by Eisenwerk Hensel, S.A. Bayreuth, W. Germany.



For high-speed blanking . . .

the main flywheel works alone. For drawing, which requires high working energy at low stroke rates, the secondary flywheel is brought into operation too. The choice—single flywheel or both—enables the same press to handle both blanking and drawing.

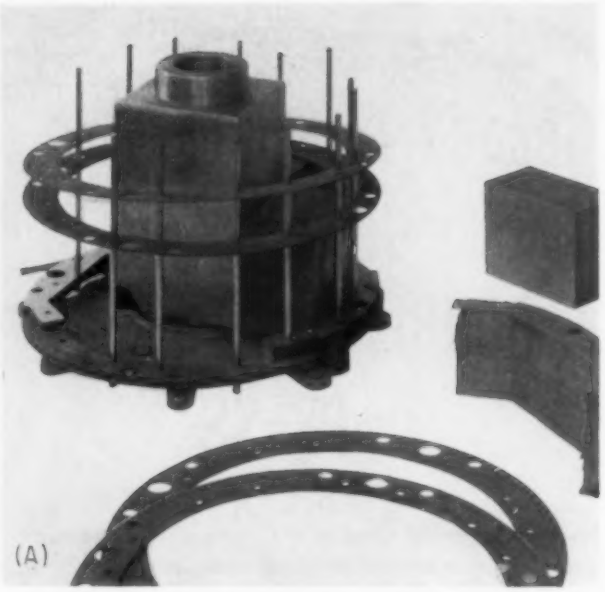
Performing both operations with one press can also be done with complex variable-speed transmission or charge gears. However, the reduced stroke rate needed for drawing, achieved by slowing down the press, results in loss of working energy and drawing capacity.

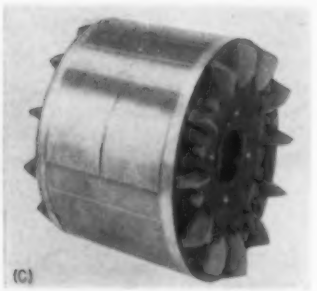
In the new method, blanking is handled by placing the V-belt on the larger motor sheave and the drive wheel; the secondary flywheel is disconnected and locked—working energy now is supplied only by the main flywheel. For drawing, the V-belt is placed on the smaller motor sheave and secondary flywheel. A rolling key clutch connects secondary flywheel to drive wheel—now working energy is supplied by both flywheels.

Cast Rotor Simplifies Generator

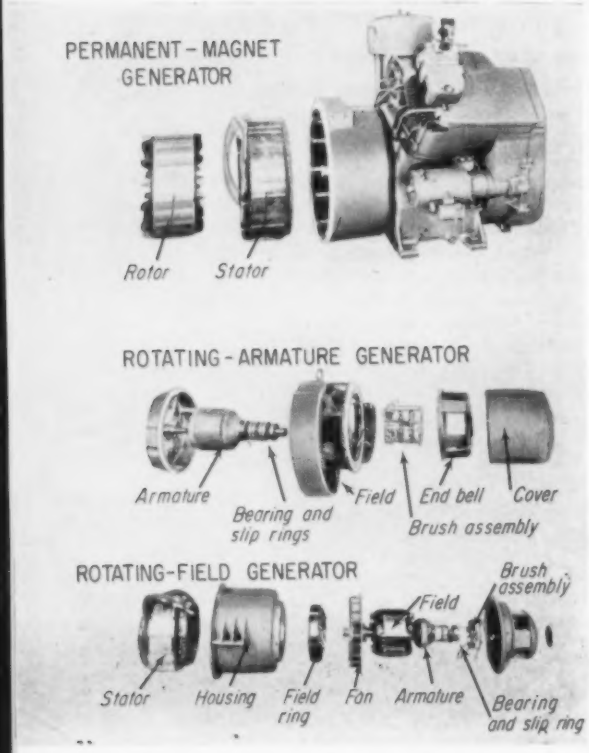
Magnets are cast in place to give the rotating field of this synchronous generator rotor for constant-voltage applications. Rugged construction results in improved electrical as well as mechanical stability in engine-driven unit.

Multifuel engine can burn diesel, kerosene, JP4 jet fuel or gasoline-oil mixture. The 2-cylinder, 13-hp engine runs at 1800 rpm to produce 5 kw at 120 v, single phase, or 120/208 v, 3-phase. Frequency is held within ½ cycle for all load conditions. The motor generator is produced by American MARC Inc., Inglewood, Calif.

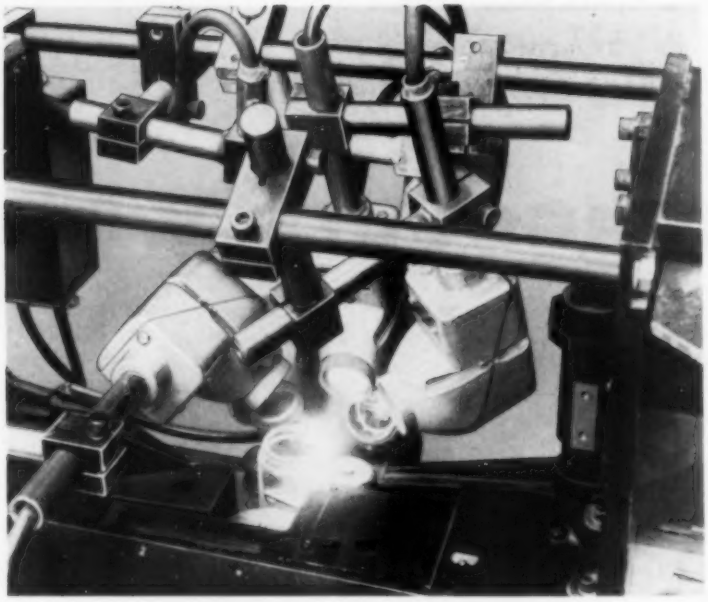




Permanent magnets . . .
in the rotor assembly are positioned by steel pins and stamping to form rotating field poles (A & B). Centrifugal casting of complete assembly (C) forces aluminum into holes in stampings, prevents voids and porosity. But main object of aluminum encasement is to improve electrical rather than mechanical qualities. Shorted turns are formed, by aluminum around magnets, to prevent permanent demagnetization by accidentally shorting output. Holes punched in pole shoes are filled with aluminum to form windings that improve wave form and transient response. During dynamic balancing the lugs, between cooling fins, are ground off or peened over lead washers. After machining, balancing and magnetizing, rotor is ready for installation.



Construction simplicity . . .
of constant-voltage, permanent-magnet generator, is obvious in comparison with rotating-armature and rotating-field units. Absence of sliding or moving contacts such as commutators, slip rings and brushes eliminates sparking contacts, reduces radio interference and explosion hazard. Rotor may be removed and installed without loss of voltage. Stator is wound in three sections with six leads. Two-wire delta connection produces 120 v; 4-wire Y-connection produces both 120 and 208 v, simultaneously providing 3-phase power and 120 v for lighting.

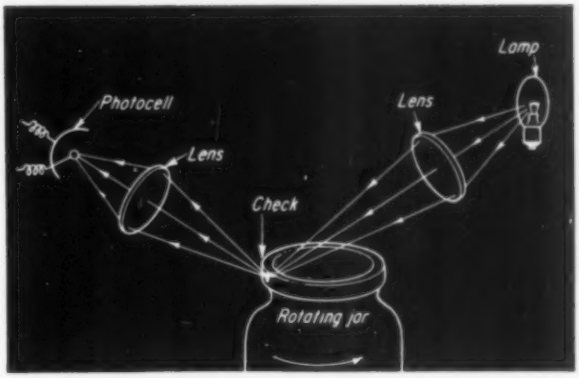


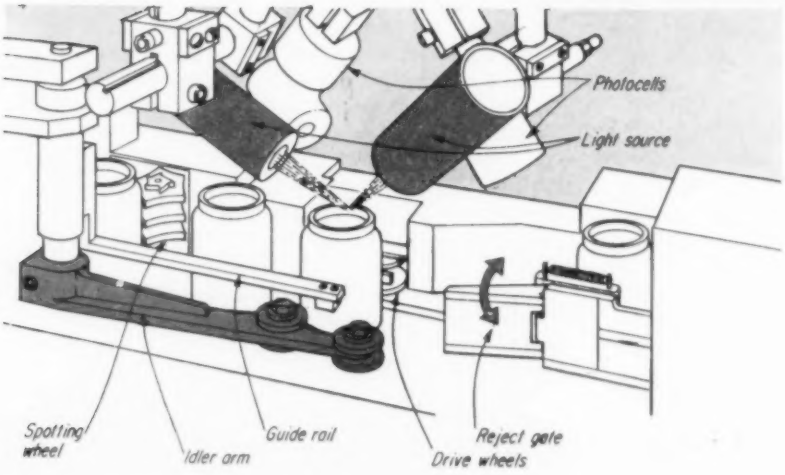
Defects in glass . . .
referred to as checks or vertical splits, are commonest cause of lost vacuum. High-intensity light source directed at rim of jar is reflected by defects to photocell, tripping reject circuit. Rotating jar permits inspection of entire rim section in one operation.

Light Catches Glassware Defects

High-speed inspection of jars and bottles is accomplished by reflected light. Unit is mounted over conventional conveyor lines, does not affect normal production processes.

Bottle inspector checks up to 83 wide-mouth jars a minute on a continuous basis. Produced by Hartford-Empire Company, Div. of Emhart Mfg. Co., Hartford, Conn.

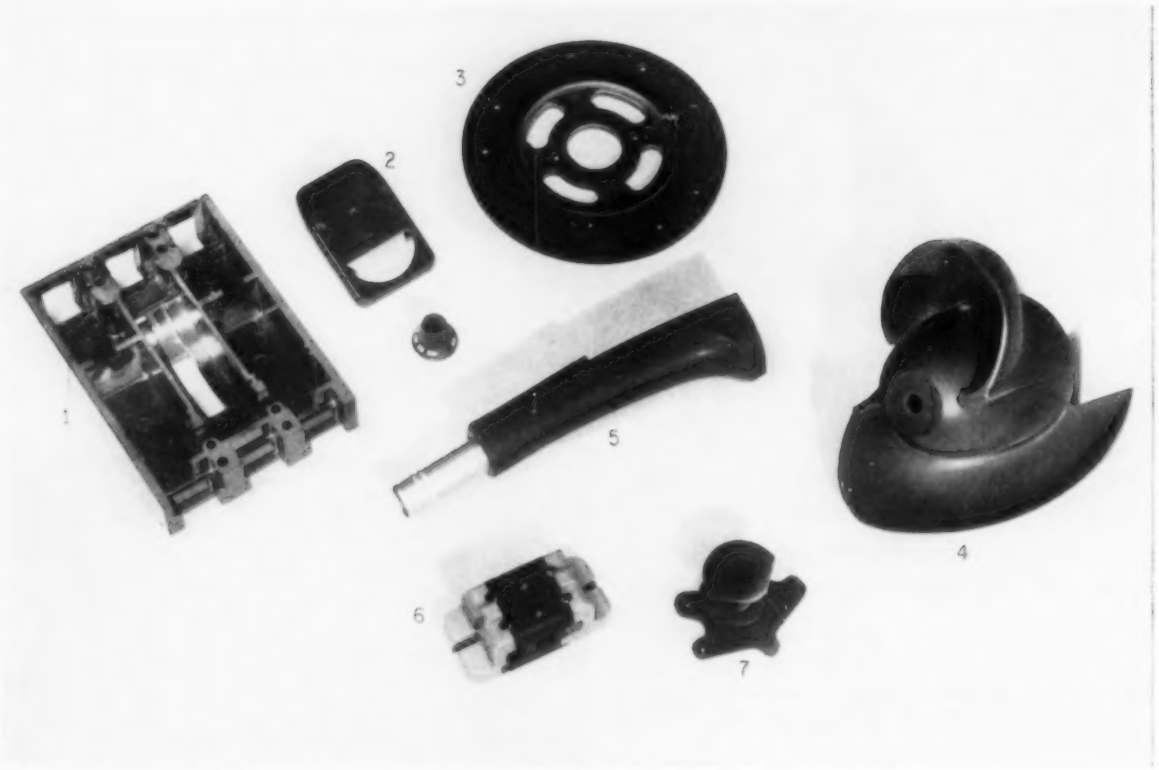




Conveyor feed . . .
delivers jars to spotting wheel which permits single jars to enter the inspection station. Switch lever operated by jar entering inspection station trips idler arm. Idler arm holds jar against drive wheels that rotate the jar. Light sources are oriented to focus two cones of probing light on the area of the jar under inspection. Defects reflect light into one or more photocells activating reject gate. Interlocks prevent reflected light from entering photocells while jar is being positioned.

Thermosetting plastic doesn't allow a second guess—it must be molded correctly the first time. That's why knowing the ground rules is so important. The examples below show how skillful design is needed to get . . .

BEST RESULTS WITH



1. Ribs provide strength and insulation for breaker box
2. Recessed lettering in dial is easier read than raised letters in meter case
3. Intricate gating molds difficult thin wheel
4. Spiral agitator is molded with 4 external pieces
5. Appliance handle, molded around stainless conduit, insulates against heat and shock
6. Large radii and draft make it easier to mold terminal block
7. Eliminating internal undercuts allows molding intricate exterior

DAVID M. BUCHANAN, *Technical Service Engineer, Bakelite Co.*

When molding phenolics the difference between economy and high cost boils down to design—good or poor. The thermosetting compounds are like concrete in not allowing a second try with the same batch of material; only a fresh start can correct error. This is why it pays to know the ground rules before molding.

Ahead of this, of course, comes choice of proper material. The phenolic powders offer high-quality parts with molded-in dimensional stability, heat resistance and creep resistance. But the supplier will also want to know special requirements of mechanical strength, electrical insulation, molding properties . . . as well as whether the parts are to stand up to such working conditions as outdoor exposure, moisture, chemical atmospheres.

Shape of the part is the next important decision. Together with the production quantity planned, mold design determines the choice of forming process—compression molding or plunger molding.

Making a model will help guide design. Models machined from the selected material aid shop studies of dimensional tolerances and clearances. Models can

PHENOLIC MOLDED PARTS

also point to improvement in shape, and reduction in size and weight—with corresponding savings in mold and production costs.

Testing is likewise useful. For example, mold dimensions should allow extra for shrinkage of parts after aging or exposure to elevated temperatures. Controlled baking of test parts at 150 F for 24 hours will induce the equivalent of one year's aging at room temperature and show the extra allowance needed. When shrinkage cracks test parts, redesign is called for.

In addition, here are ground rules to follow when molding phenolics:

Better Flow

Under heat and pressure, the plastic is changing rapidly from a sluggish, molten mass to a hard, rigid structure. Result is a complicated flow pattern. If restricted, it causes variations in density and poor welding of plastic around core pins. Single-cavity parts will reveal incorrect design—for example, non-uniform wall thickness which gives gas pockets, and stagnant areas in the mold where free movement of material is retarded. Optimum mechanical, electrical and chemical properties call for streamlining the flow.

Shrinkage

While compensation for shrinkage is usually the mold-maker's problem, some fundamentals must be understood for proper design.

- Shrinkage is essential. Without it, parts cannot be removed from the mold cavity. Difference between dimensions of the mold and molded piece measured at room temperature range from 0.001 to 0.015 in. per in. depending upon type of resin, filler, plasticity, expansion of the mold, process, and molding procedure.
- Uniform cross-section helps give uniform shrinkage. In a non-uniform part, when molding procedure is adjusted for the difficult thin section, the thick section will not fill or will cure inadequately, and so shrink unevenly.
- Nominal molding tolerances can be controlled to ± 0.003 in. per in. for a correctly designed part. However, this accuracy is met only at increased cost in mold building and molding procedure.

Locating the Parting Line

All molded pieces show a parting or flash line where mold sections join. In compression molding, this ridge is 0.001 to 0.003 in. thick and must be removed by tumbling or by hand. The plunger-injection process gives less flash because the plastic is injected into an already closed mold. When irregular shapes do not permit easy removal of flash, the parts will require costly hand filing and buffing.

Undercuts

Molds must provide a method of ejecting the molded pieces. Parts with undercut call for split molds or loose pieces. Undercuts increase upkeep of the mold and add to flash, so should be avoided.

Slight undercuts such as shallow threads can be molded by stripping or unscrewing the part from the force plug immediately upon ejection.

Wall Thickness

The section should withstand ejection from the mold. Wall thickness is also determined by structure, weight, strength, dimensional stability, dielectric strength, and electrical resistivity. Anticipated stresses should be distributed evenly, but increasing wall thickness isn't always the answer. It may give added costs from longer curing times. Often high-impact materials in thinner walls are a cheaper answer.

Draft

Ejecting molded parts when rigid, and from deep cavities, is difficult without draft in the mold. The amount varies with depth of draw. A good rule: specify the most liberal draft the design will allow. Minimum practical draft is 0.001 in. per in. for a 24-in. depth.

Fillets, Radii, Ribs

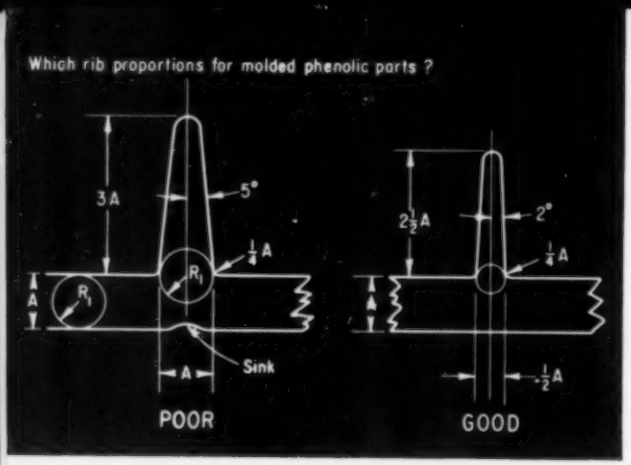
Eliminating stress concentration at sharp corners reduces cracking and increases resistance to impact. Min radius for all internal and external corners is $\frac{1}{4}$ times thickness or $\frac{1}{64}$ in., whichever is larger. However, little benefit is gained from radii greater than $\frac{3}{4}$ the thickness.

Fillets and radii also promote uniform flow of the hardening phenolic. Costs are lowered, too, because steel molds with sharp corners frequently crack while hardening.

High structural strength with minimum cross-section is given by molded ribs. They increase rigidity and strength, and help prevent warpage. When properly designed, they reduce or eliminate sink marks.

Pads and Bosses

For assembly with metal fasteners, the best local reinforcement is with pads or bosses. Bosses are generally located in the corner of the molded part. In minimum dia, they should be three times the hole



size; in height, not more than twice the diameter. When too large, they lower strength by trapping gas.

Molding-in Holes

If walls are thick enough, holes of any cross-section can be molded into parts. Breakages frequently show disregard of these basics:

- Length-to-dia ratio too great—answer is to support core pins at both ends and make them retractable.
- For deep holes, butt two core pins together. This offsets possibility that unbalanced flow of the plastic will shear pins. Make one pin 0.030 in. larger in dia to compensate for misalignment. Grind the flat ends of the pins with 0.003-in. clearance.
- Include taper in core pins 0.187 in. dia or larger to permit easy extraction.
- For blind holes, limit length of core pins to twice the diameter. If blind holes are ⅛ in. dia or smaller, length should not exceed diameter. Where smaller-dia holes exceed the molded length, drill the remainder of the hole.
- Plunger-injection mold where the hole is at right or oblique angles and the core pin is not parallel to direction of plastic flow. Streamline flow from the mold gate to prevent imperfect welding of the plastic at the pin-side opposite to direction of flow.

Threaded Holes

Molded or tapped threads finer than 32 threads per in. are not recommended. When molding holes for tapping, countersink to ease tapping, and to eliminate need for machine countersinking. The countersunk edge will also prevent edge cracking, ease insertion of screws, and speed assembly.

Tapped threads in phenolic molded parts are stronger than hardened screws. For screws 2½ times longer than dia, the head will twist off before the threads will strip.

Self-tapping or drive screws eliminate threaded holes. Drive screws which are hammered home cannot be removed easily so should be used only as permanent fastening. Molded holes for self-tapping and drive screws should have a rounded chamfer at the lip.

Inserts

Metal inserts in molded phenolics should be avoided because they present hidden production problems—for example, inserting into a mold at 300 F is difficult and slows the molding cycle. It's better, and faster, to stake into parts by automatic methods. Metal eyelets, drive screws, self-tapping screws, or standard machine screws or bolts and nuts can all be incorporated after molding.

When inserts are necessary, brass and aluminum have the coefficient of thermal expansion most compatible with expansion of commercial phenolics. For firm anchorage, diamond-knurl the insert. For accurate location, hold it snugly in the mold.

Surfaces

The finished appearance of a phenolic part is determined by surface of the mold cavity. For best finish, free flow, and easy removal from the mold, the cavity is polished to a mirrorlike finish. However, large, continuous, polished surfaces easily show flow marks and blemishes. To break up such surfaces try a satin finish or treatment like fluting, stipling, diamond knurl, or leather grain.

Single Mold Cavity

Parts molded from a single cavity determine shrinkage, correct dimensional tolerances, dimensional accuracies in fit between component parts, and interchangeability in assembly. Here, too, the chosen material can be tested for mechanical strength, electrical or chemical properties. The method also determines weight of charge for accurate molding costs, molding cycles, final size of molds, and production output.

For lowest cost, the single-cavity mold should be designed to serve as a contour-master for reproduction of other cavities and allow incorporating it as one unit of the multiple-cavity production mold.

Color

No longer are phenolic colors limited to dark shades of brown or black; they range from black to white and include all pastels. These colors can be added by sprayed or dipped epoxy finishes developed for the purpose. Coated parts are then baked to give a tough adherant surface with good scratch resistance.

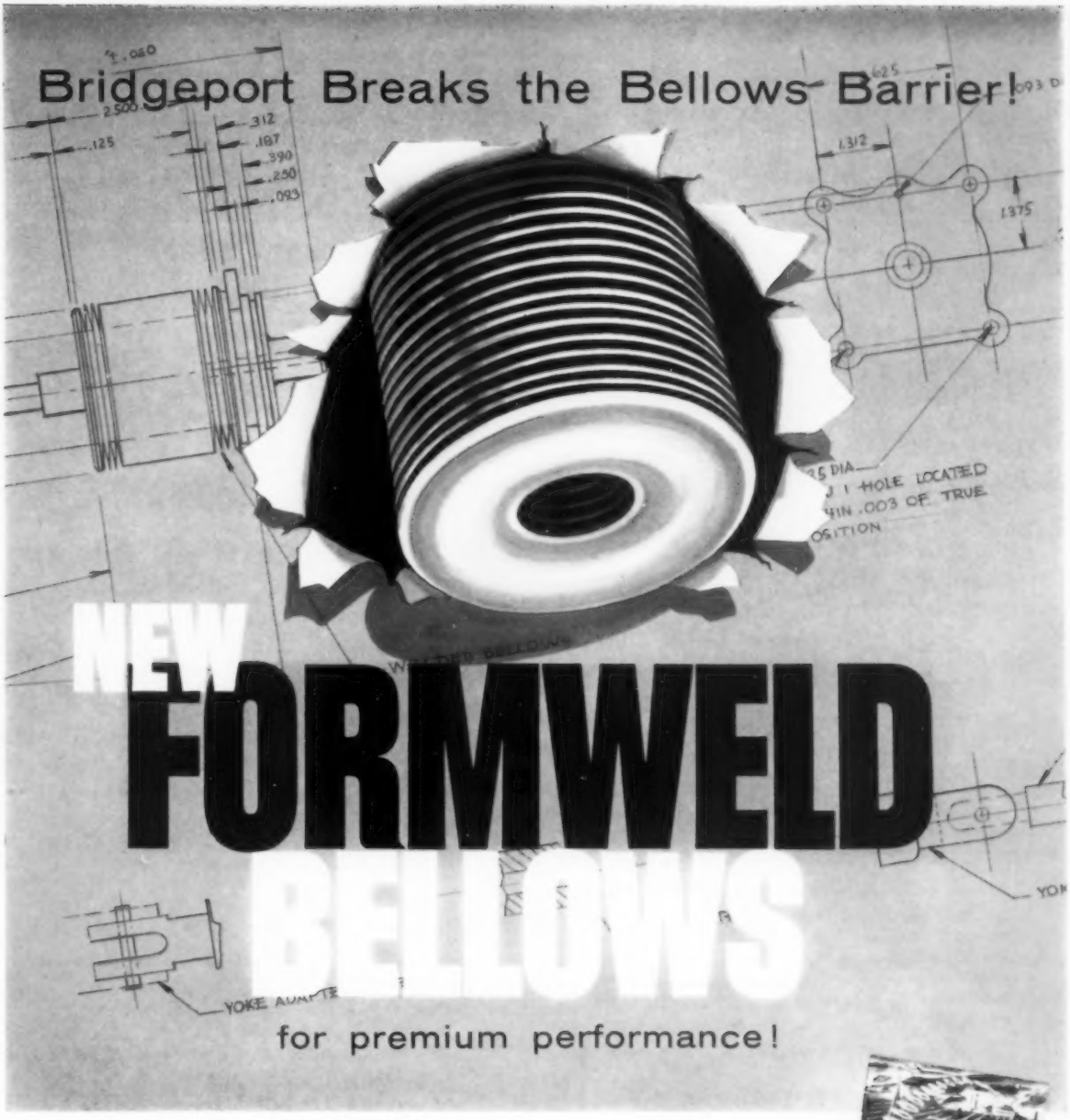
Molded Lettering

To permit easy removal of a lettered part from the mold, provide adequate draft to all letters and arrange them perpendicular to the parting line.

Both raised and depressed letters are common. Engraving depressed letters in the cavity will form raised letters on the molded part. This costs less than raised lettering on the mold to give recessed letters. Depressed lettering is somtimes preferred because of better legibility of paint-filled recesses.

EDITOR'S NOTE: Other articles on molding and design of plastics and elastomers:

"High-speed Molding Process Cuts Cost of Rubber Parts," June 23, p 69, describes continuous process which molds accurate rubber parts and is adaptable to thermosets; "Which Plastic for Abrasion Resistance," Mar 31, p 105, gives handy selection chart for elastomers and rigid plastics that require resistance to abrasive wear.



Now . . . you can confidently specify metallic bellows for even the toughest combination of environmental and service conditions . . . and get the most accurate and reliable bellows ever built!

Now . . . service limits are greatly increased by a wider choice of bellows metals, including Inconel-X, titanium, zirconium, Hastelloys, Monels, Ni-Span-C, 17-7 PH and 300 and 400 stainless steels, beryllium copper, super corrosion resisting and other weldable alloys.

Precision welding results in exacting control of dimensional tolerances on free length, I.D., O.D., parallelism of plates and end fittings, and concentricity of end fittings. Improved properties in FORMWELD Bellows include greater temperature, corrosion and fatigue resistance, ability to withstand higher loads without deformation, lower hysteresis with greater linearity, and complete uniformity of properties. More free plates per inch assure space savings. Available in sizes from $\frac{1}{4}$" to 18" plus O.D.

WRITE FOR BULLETIN A 709

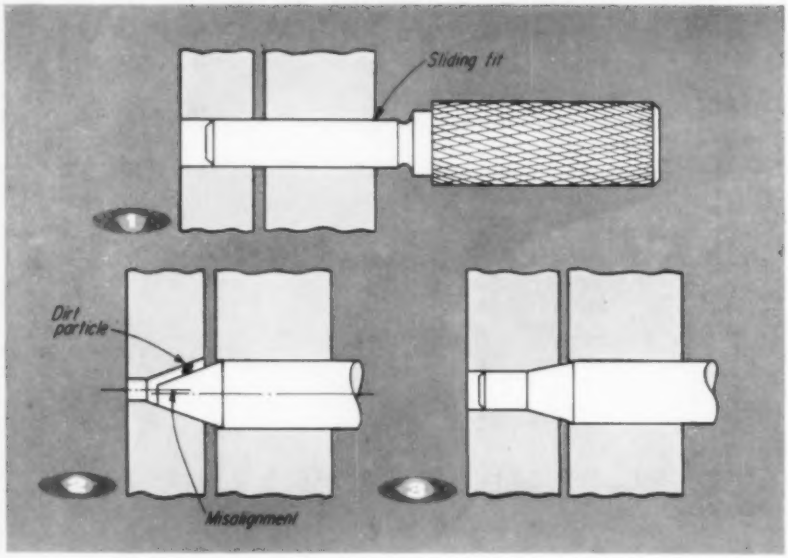
Mr. Controls

Robertshaw-Fulton
CONTROLS COMPANY

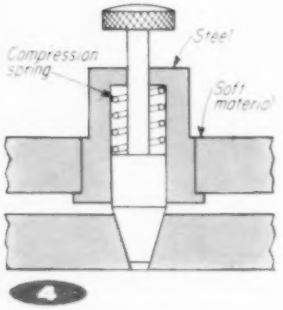
BRIDGEPORT THERMOSTAT DIVISION
Milford, Connecticut

14 INDEXING

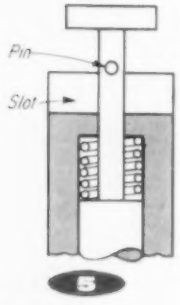
Many mechanisms have moving parts that require accurate positioning at one or more locations. Here is a variety of ways showing how to do it.

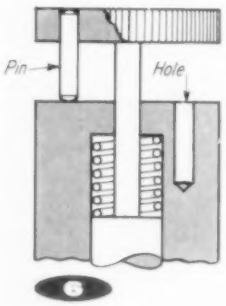


Round rod in holes . . .
can be close, sliding fit—or comparatively loose, with correspondingly less accuracy. In either case, this device gives simplest indexing method (1). Tapered rod (2) in mating hole is frequently used for aligning parts, but not always advisable; dirt or other foreign matter can reduce alignment accuracy. Best solution (3) is combination of cylindrical and tapered fingers, but higher cost usually limits this design to more expensive products.

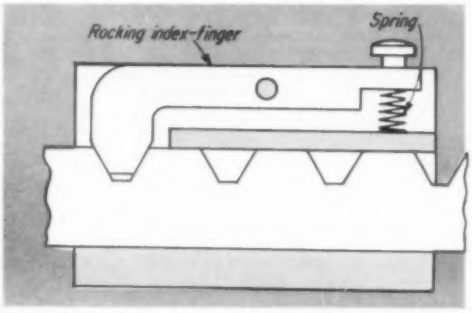


Spring-loaded plunger . . .
is nonremovable, therefore more suitable in most cases. Plunger spring should not be too stiff if frequent operation is necessary.





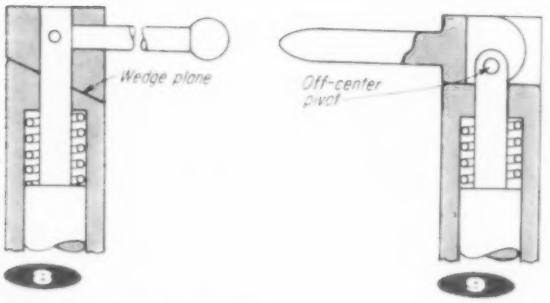
Stop-pin . . .
through shaft (5) lets spring-loaded index finger be held inoperative, without need for the operator to do it manually. In indexing position, pin sits at slot bottom. Knob pin (6) achieves same results but in dirty conditions hole may become filled with foreign matter, preventing proper index action.



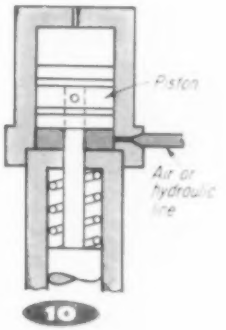
Rocker-type index . . .
shown here is only one of many similar types. Chief feature: Finger does not have to be circular, spring is not co-axial and device can be modified to become escapement-type, double-acting index by adding a second finger-end on other side of pivot.

DEVICES

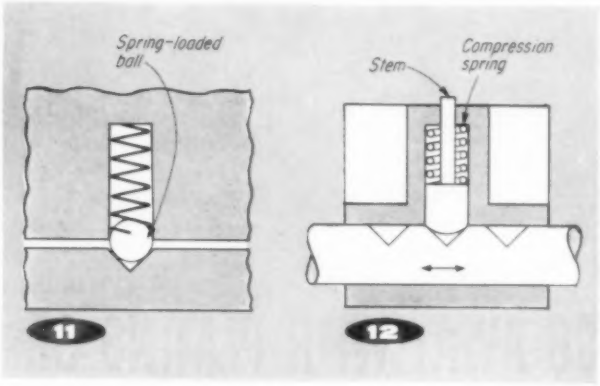
FEDERICO STRASSER, *Mankowitz and Stasser, Ltd., Santiago, Chile*



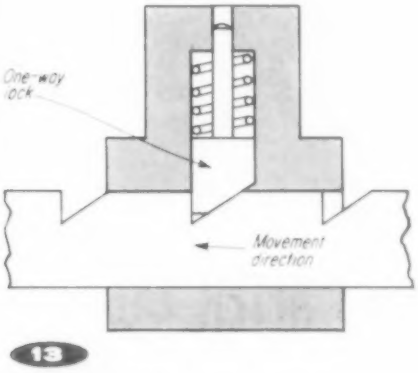
Wedge (8) and eccentric (9) . . .
hold plunger in closed position. These designs can serve in large and small applications. Lubrication is important unless action is only light and infrequent.



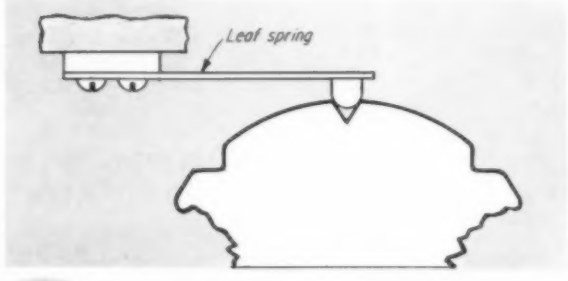
Piston-actuated . . .
index plunger is one example where plunger is operated by means other than a spring (gears and screws can also operate plunger). Such designs are more expensive but are often the only solution when locations are inaccessible.



Spring-loaded ball . . .
provides automatic indexing (11) that is responsive to force. When the force applied to movable member exceeds a certain value the ball retracts. More elaborate is domed plunger (12) with stem extending through mounting. By adding a static force, such as weights, to the stem, the response can be adjusted to suit various values of movable-member force.



One-way index . . .
acts in same fashion as ratchet and pawl. Main difference: Comparatively large force is required to raise plunger and move the part, whereas in ratchet mechanism the pawl should require only light forces to move it.



Rotary index . . .
employing leaf spring in economical arrangement is example of such indexes where only relatively rough indexing is required. More accurate rotary indexing requires elaborate and expensive setup.

"...AND WEIRKOTE® CAN DO AWAY WITH PLATING OR DIPPING AFTER FABRICATION! IT WON'T PEEL OR FLAKE."

Q. A zinc-coated steel that won't peel or flake? That could save us a lot of money every month. Just what makes this Weirkote so special?

A. It's made by the continuous process, you know, which integrates zinc and steel so that the toughest fabrication won't break down the bond. You can work Weirkote to the very limits of the steel itself.

Q. Of course, that means the most complicated parts would have protection against rust. I like what I'm hearing. Is there more?

A. Yes . . . now Weirkote is treated to inhibit wet storage stain (white oxide). To make a long story short, I'd say this: With Weirkote, you can turn out a better product at lower cost. And you can free a lot of the capital, floor space and time you have tied up in plating operations.

Send for free booklet that details the time- and cost-saving advantages of skin-tight zinc-coated Weirkote. Weirton Steel Company, Dept. D-7, Weirton, West Virginia.

CIRCLE 117 READER SERVICE CARD

WEIRTON STEEL COMPANY

WEIRTON STEEL COMPANY

WEIRTON, WEST VIRGINIA

a division of

NATIONAL STEEL CORPORATION

how to calculate STRESSES in PRESS-FIT BUSHINGS

Here is a family of formulas, each helpful for a typical application.

E. H. SCHUETTE,
Chief of Applications Research, Dow Chemical Co, Midland, Mich.

With light metals, press-fit bushings greatly increase the strength of bearings and give only a small increase in weight. Many light-metal alloys, however, are sensitive to stress corrosion. Tensile stresses produced by an interference fit should, therefore, be kept to a safe level. Here, beginning on this page, are formulas that will help do this.

The formulas for cases I and II are extensions of the formulas for pressurized, thick-wall cylinders.

In cases III and IV the derived formulas were too long to be of practical value. To simplify them, therefore, 237 specific examples were calculated on an electronic computer. All probable designs were covered. Formulas III and IV, using arbitrary increase of dia c, were developed as a result of the electronic computation, and give results that are 99% accurate.

KEY TO FORMULAS

$$A = \frac{b^2 + a^2}{b^2 - a^2}$$

$$B = \frac{b^2}{c^2 - b^2}$$

$$C = \frac{c^2}{c^2 - b^2}$$

$$D = \frac{d^2 + c^2}{d^2 - c^2}$$

E = modulus of elasticity, psi
S = stress, psi
c = interference, in.
μ = Poisson's ratio

Subscripts:
B = bushing
M = matrix metal
S = sleeve
1 = matrix-sleeve interface
2 = sleeve-bushing interface

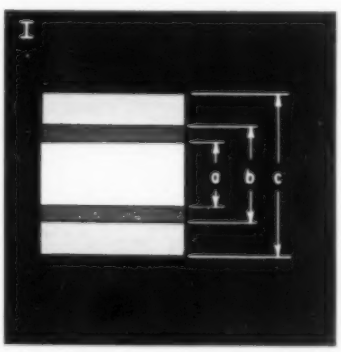
Assumptions Behind Formulas

Assumption for cases I and II is that the outer bushing-face must deflect to a position coincident with the inner matrix-face. Since pressures on these two faces are equal (one reacting against the other) it is possible to say that matrix deflection minus bushing deflection equals the amount of interference. In cases III and IV, conditions governing analysis are:

1. At any position along the length, an unbalance may exist between internal matrix-pressure and the external bushing-pressure.

2. The total of unbalanced forces up to the given position, over a unit circumferential width, is balanced by total shear force on unit circumferential width of cross-section at that position.

3. Slope of the deflection curve at any position must be related, by rigidity modulus, to shear stress.

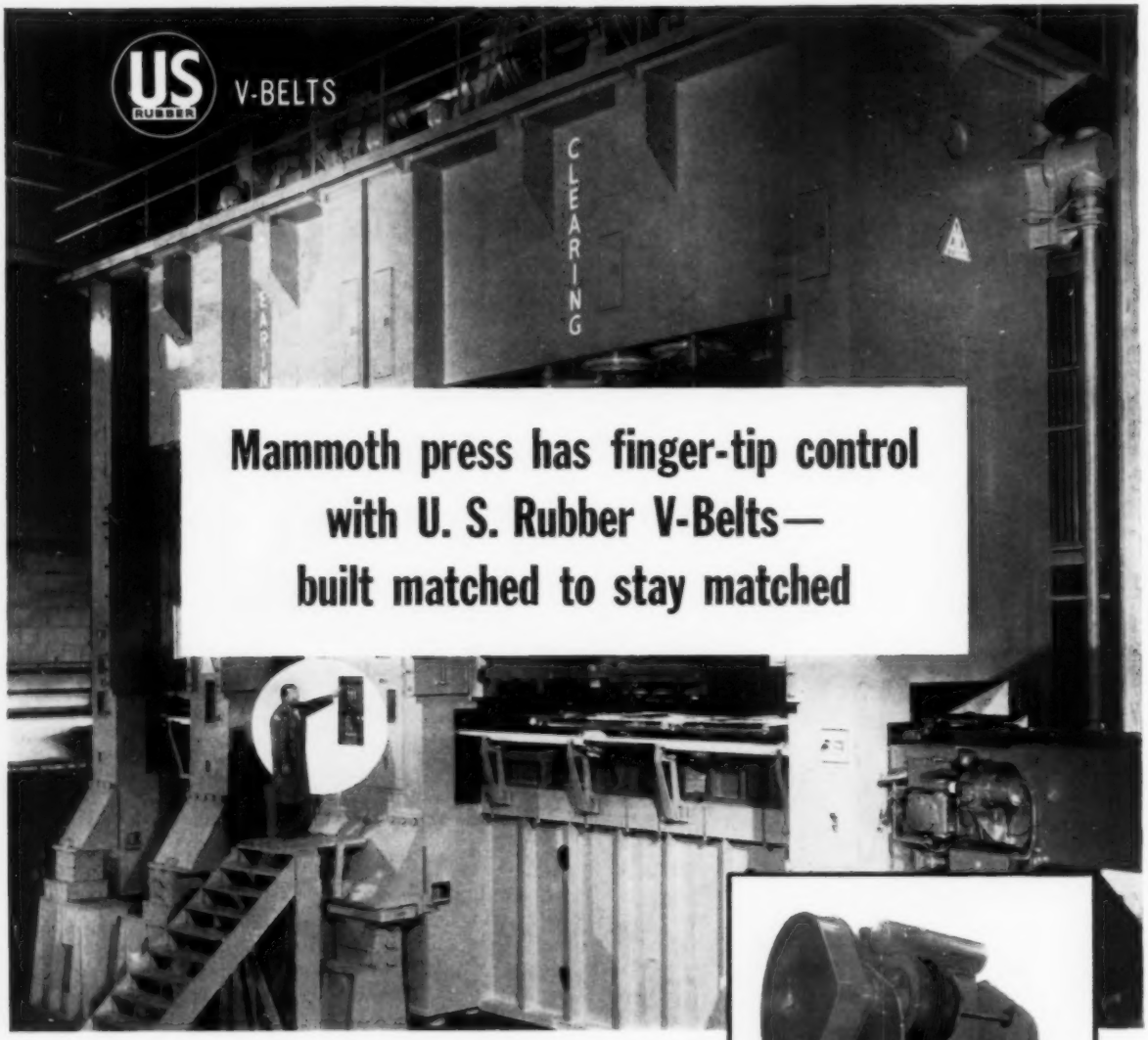


$$S_M = \frac{E_M \frac{c}{b} (B + C)}{(B + C + \mu_M) + \frac{E_M}{E_B} (A - \mu_B)}$$

Matrix metal, bushing . . .
have the form of a cylinder. This formula is an extension of those for thick-walled cylinders with internal pressure.

(continued on page 53)

US RUBBER V-BELTS



Mammoth press has finger-tip control with U. S. Rubber V-Belts— built matched to stay matched

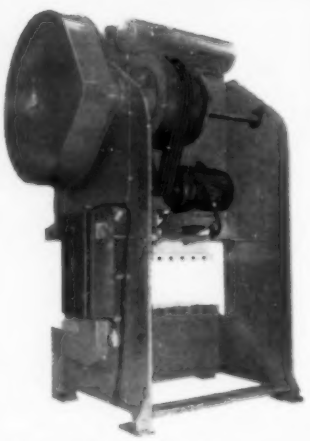
This triumph of press automation is believed to be the largest transfer feed press in the world. It was made by Clearing Machine Corp., Chicago, for General Electric's Home Laundry Department, Louisville, Kentucky. The press is 58' long, more than 42' high, and can produce tops for both G-E automatic washers and dryers without changing dies.

The tremendous shock loads transmitted by the press are controlled by 19-foot long U. S. Rubber V-Belts. Through a new method of construction, "U. S." belts of even this length—and longer—are produced to such close tolerances that there is no problem of matching belts for exacting response without lag or drag. That's one reason why these "U. S." belts stand up under the split-second movement of great forces . . . why they distribute the load to insure efficient pull with minimum stretch.

U. S. Rubber V-Belts are made in the world's largest and most modern plant devoted exclusively to the manufacture of endless belts.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.



Close-up of smaller steel forming press. Thanks to an exclusive method of manufacture, a set of U. S. Rubber V-Belts like these can be picked right from stock with the guarantee that they will *match perfectly*. No testing necessary.

US RUBBER

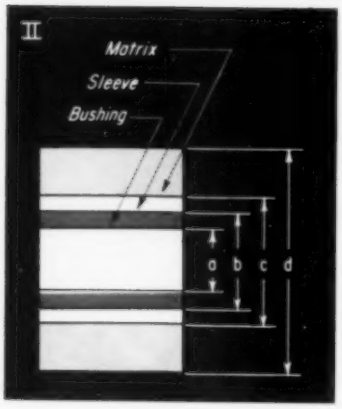
Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

STRESSES IN PRESS-FIT BUSHINGS (cont.)

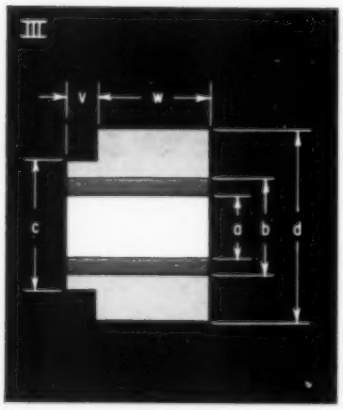


Sleeve between matrix . . .
and bushing complicates formulas. But though lengthy, the formulas involve only simple arithmetic calculations.

$$S_M = p_2 D \qquad S_S = p_1 (B + C) - 2 p_2 D$$

$$p_1 = E_M \frac{\frac{c_1}{b}\left[(D + \mu_M) + \frac{E_M}{E_S}(B + C - \mu_S)\right] + \frac{c_2}{b}\left[2\,\frac{E_M}{E_S}\,C\right]}{\left[\frac{E_M}{E_S}(B + C + \mu_S) + \frac{E_M}{E_B}(A - \mu_B)\right]\left[(D + \mu_M) + \frac{E_M}{E_S}(B + C - \mu_S)\right] - 4\left[\frac{E_M}{E_S}\right]^2 BC}$$

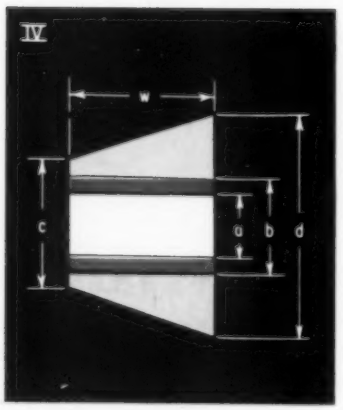
$$p_2 = E_M \frac{\frac{c_1}{b}\left[2\,\frac{E_M}{E_S}\,B\right] + \frac{c_2}{b}\left[\frac{E_M}{E_S}(B + C + \mu_S) + \frac{E_M}{E_B}(A - \mu_B)\right]}{\left[\frac{E_M}{E_S}(B + C + \mu_S) + \frac{E_M}{E_B}(A - \mu_B)\right]\left[(D + \mu_M) + \frac{E_M}{E_S}(B + C - \mu_S)\right] - 4\left[\frac{E_M}{E_S}\right]^2 BC}$$



Stepped matrix . . .
causes stresses, pressures and deflections to vary over total length. Formula here derives value of Δc, which gives 99% accurate results when combined with formula for I.

Use formula for case I, substituting $(c+\Delta c)$ for c in $\left(C = \frac{c^2}{c^2 - b^2}\right)$

$$\frac{\Delta c}{b} = \left[\frac{1 + \frac{2a}{b}}{3}\right]\left[\frac{\frac{d-c}{b}}{\frac{d-c}{b} + 1}\right]\left[\frac{\frac{w}{b}}{\frac{w}{b} + \frac{v}{b}}\right]^{1 + \left(\frac{2w}{b}\right)}$$



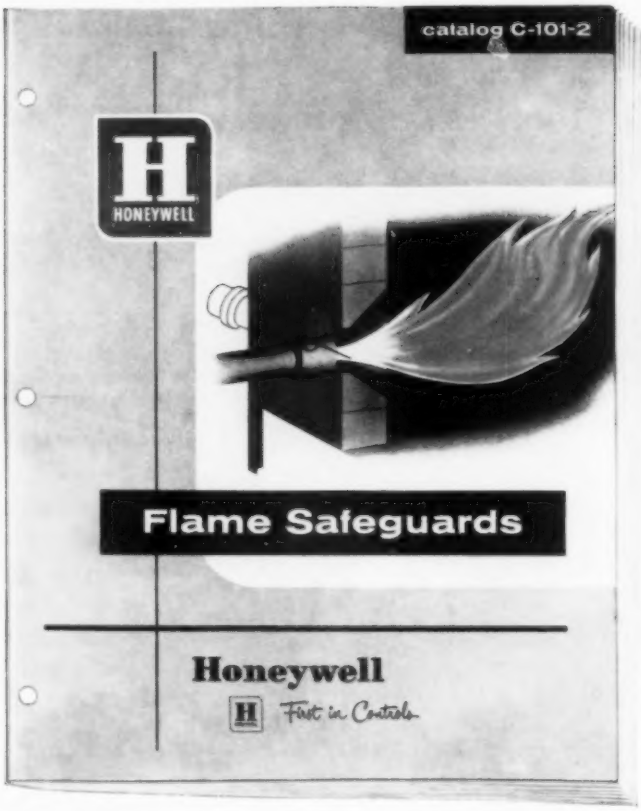
Conical-matrix . . .
formula gives Δc, which is then also incorporated into formula for I, giving same degree of accuracy as III.

Use formula for case I, substituting $(c+\Delta c)$ for c

$$\frac{\Delta c}{b} = \frac{1}{2}\left[\frac{d-c}{b}\right]\left[1 - \frac{(w/b)^2}{(w/b)^2 + 2}\right]$$

NEW!
Honeywell Flame Safeguard Catalog...

...describes and illustrates all components—complete systems—for protecting plant, personnel, and product in industrial gas and oil-burning installations.



Send for your free copy today

Protectoglo Relay, one of a complete line of Honeywell flame safeguards

Honeywell Catalog C-101-2 tells you about new, up-to-date flame safeguard equipment for every conceivable type of single and multi-burner installation. It includes specifications and illustrations of every unit, and explains how each operates. Also included is useful information about auxiliary equipment—switches, valves, relays, timers, etc. MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

FILL OUT AND MAIL THIS COUPON

MINNEAPOLIS-HONEYWELL
Wayne and Windrim Avenues
Philadelphia 44, Pa.

Please send me the new Flame Safeguard Catalog C-101-2

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State _____

Honeywell

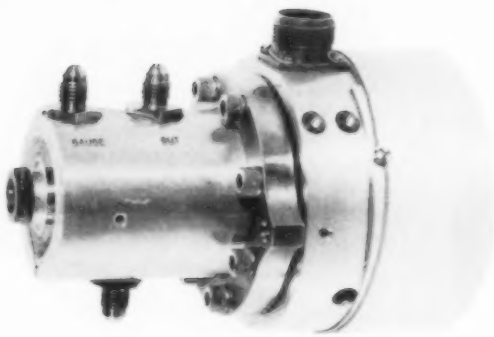
First in Control

SIGNIFICANT COMPONENTS • MATERIALS • PROCESSES

Motor operates at full hp only underwater . . .

depending on that fluid for cooling and lubrication. Water (fresh or salt) circulates through electrical and mechanical components and is kept from windings by irradiated polyethylene insulation. Motor will operate at full load satisfactorily as long as fluid temperature around windings does not exceed 125 F. Suitable for drive and pumping applications. Can pump fluids at temperatures from freezing to 600 F, using thermal barrier and heat exchanger to limit fluid temperature inside motor. Available 100 to 2000 hp in various squirrel-cage designs. 6-wk delivery, min. **General Electric Co, Schenectady 5.**

Circle 1, inside back cover



Regulator programs pressure systems . . .

where operation at different pressure levels or sequences is needed. Equipped with three 18 to 30-v dc continuous duty solenoids wired to 3-way switch and 2-position safety switch that activate metering valves within regulator from remote position. Infinitely-variable pressure over a wide range may be loaded or vented with speed and sensitivity. Built-in, automatic relief valve and a preset pressure limit valve compensate automatically. Inlet pressures range from 50 to 6000 psi; proof pressure is 9000 psi; burst pressure, 15,000 psi. Outlet pressure ranges from 30 psi to 30 to 200 psi below inlet pressure. Rated capacity is 0.1 (scfm/psia) min, as per military specifications. $495 each; 6 to 8-wk delivery. **Marotta Valve Corp, P O Box 330-40, Boonton, N. J.**

Circle 2, inside back cover

One-coat organic finish . . .

replaces plating and electrochemical coloring methods on metals. Where used to simulate a metal, it is said to be indistinguishable from that metal and has advantage of being nontarnishing and requiring no maintenance. Offered in brass, gold, copper, bronze and a variety of colors. Metal requires no pretreatment. It can be sprayed, dipped or roller coated–then baked at 400 F for 7 min and 325 F for 15 min. Unaffected by temperatures from 0 to 675 F. Finish can be post-formed. Said to cost about 80% less than plating; 50% less than anodizing. **Permatron Co, 2117 E York St, Philadelphia 25.**

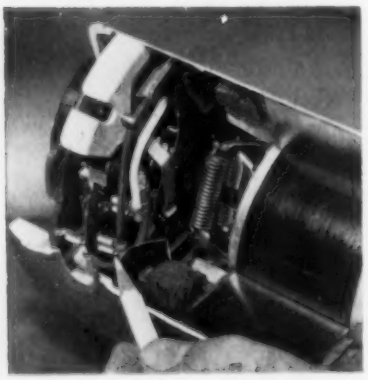
Circle 3, inside back cover

. . . CONTINUED ON PAGE 56

Vinyl powder coatings . . .

are applied to metals in a fluidized finishing process. Metal parts to be clad are preheated to a temperature above flow point of vinyl resin and dipped into a bed of dry fluidized vinyl powders that encapsulate object and bond by fusion. Uniform cladding thicknesses from 10 to 50 mil are said to be possible in a single dip. Finishes do not incorporate a solvent. Surface-preparation procedures prior to cladding comparable to those normally used. Available in a variety of colors. Reported to have color and gloss retention. **National Polymer Products, Inc, 125 N Fourth St, Reading, Penna.**

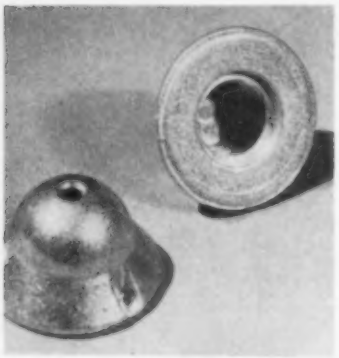
Circle 4, inside back cover



Wiring redesign in motors . . .

is available, where appropriate, on split-phase, capacitor-start, permanent-split capacitor and polyphase Form G motor types. Plug-in quick-connect terminals for internal and external connections (see pencil point in photo) are said to cut wiring time in half. Shaft rotation can be reversed without tools by interchanging two plug-in motor leads. Voltage can be changed on dual-voltage motors by sliding two brass links into position. Ground connection can be made with lug designed into end shield, just inside terminal box opening. Built-in lug is easily reached for connecting a grounding conductor necessary in some applications and meets UL standards. **General Electric Co, Schenectady 5.**

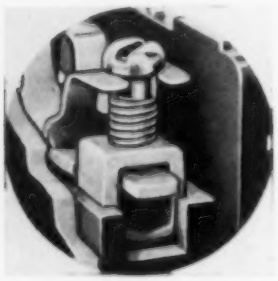
Circle 5, inside back cover



Tamperproof cap nuts . . .

of die-cast zinc are said to prevent pilfering of wheels from carts, wagons and similar vehicles. Tapered hub-cap design permits removal only by special wrench. Base of nut has wide washer-type configuration with three notched recesses to accommodate wrench. Base eliminates need for separate washer. Tapered sides prevent pliers from securing a strong enough grip to loosen nut. A ¾-in. size with ½-13 thread is now available from stock, but range of sizes is being planned. Samples may be obtained. **Gries Reproducer Corp, 400 Beechwood Ave, New Rochelle, NY.**

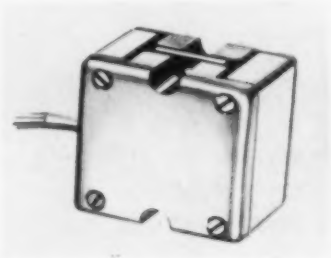
Circle 6, inside back cover



Redesigned terminal block . . .

is delivered in open position, ready for use; prevents dropping and loss of screws by spring clip on each terminal, which retains screw when backed out, yet makes removal possible. Screw can be snapped back into place in spring, if removed, and turning and vertical movement is permitted. Rated at 750 v, 50 amp. Available with from one to 20 terminals for use with AWG No. 8 to No. 18 wire. Suitable for use with power circuits. **Curtis Development & Mfg Co, 3250 N 33rd St, Milwaukee 16.**

Circle 7, inside back cover



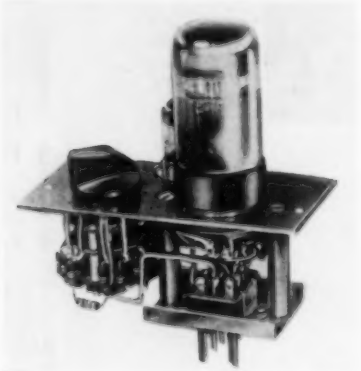
Lightweight torque motor . . .

is available with various rates of midposition force, coil resistance and rated current. Midposition force at 28 milliamp is 5 lb. Max continuous current per coil is 28 milliamp. Symmetrical armature allows large lateral accelerations without effect on armature position. Counterbalances may be added if linkage balance is desired. Two coils provide either series or push-pull operation. Operates in temperatures of from −65 to 400 F. Weighs 6 oz. For applications requiring a high-response, high-force transducer. **Cadillac Gage Co, West Coast Div, P O Box 546, Costa Mesa, Calif.**

Circle 8, inside back cover

Predetermining counter . . .

controls machine cycling, batching, sorting, packaging and unit flow at speeds higher than 100/sec. Electronic counter has plug-in decades that permit expansion from a 2- to a 3- or 4-decade counter with no wiring change. Power supply is also a plug-in unit. May be actuated by relay, photoelectric control, microswitch or toggle switch. Counting capacity of a



. . . CONTINUED ON PAGE 58

BRIDGEPORT BRASS
COPPER ALLOY BULLETIN

Bridgeport Reporting New Developments in Copper-Brass Alloys and Metalworking Methods

HOW COPPER BENDS TO THE TASK OF SQUEEZING IMPURITIES OUT OF AIR

The Hankison Condensifilter in which the tubed condenser (left above) is installed.

Here is a remarkable example of the outstanding *natural* qualities of copper tube—its ability to bend easily, resist corrosion and transfer heat. The Hankison Corporation, Canonsburg, Pa. makes a compressed air Condensifilter, in which they have used $\frac{3}{8}$" Bridgeport copper tube in an amazingly compact and efficient condensing unit.

Over 66 feet of the tube is formed into a series of hairpin bends to provide more than 900 square inches of heat exchange area. The unit in which the tube is used is the heart of the Condensifilter. In service, air coming from the compresser passes through this condenser. Cooling water, circulated through the tube, cools the air and causes moisture and oil vapors to condense out of the air stream. The very function of the unit exposes it to corrosive condensate. Copper's natural corrosion resistance, coupled with its workability, makes it virtually the only metal that can do this job so well.

Bridgeport copper and brass alloys lend themselves to many applications that many other metals cannot fill. Their workability, economical cost, resistance to corrosion, and long operating life are important advantages.

To learn more about Bridgeport metals and what they can do for you, call your Bridgeport Salesman. Backed by Bridgeport's Technical Service, he can give you valuable assistance in selecting the metal best suited to your product and production process.

Brass Alloys Offer These Advantages Over Other Metals at Competitive Prices

Today, brass is competitively priced. Everyone can now afford to put superior quality into their finished product by making use of the many advantages only brass can offer. Here are the benefits Bridgeport Alloys give you.

Higher quality—Strip with exceptionally fine surface and close tolerances is produced by our newly installed Sendzimir mills.

Lower finishing cost—The inherent beauty, lustre, and color of solid brass are far superior to those of other materials.

Scrap value—The value of brass scrap is an important factor in *final* metal costs. It offers a more advantageous return than steel or stainless.

Easier fabrication—The excellent machinability of brass means higher production rates and longer tool life.

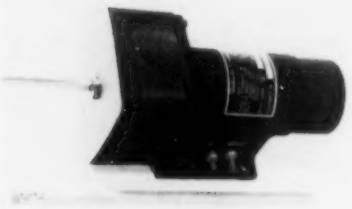
Bridgeport's Technical Service is always ready to show you how brass can do a better job than the metals you are now using. Take advantage of the superiority of brass—call your nearest Bridgeport Sales Office.

BRIDGEPORT BRASS

Bridgeport Brass Company, Bridgeport 2, Connecticut • Offices in Principal Cities
In Canada: Noranda Copper and Brass Limited, Montreal

4-decade unit is 10,000, used as a predetermining counter. As a totalizing counter, with 4 decades and a 4-digit mechanical register, counting capacity is 1,000,000. It will simultaneously reset to zero and repeat its counting function without loss of count. The 3-decade counter is $295; individual decades (illustrated) are $50. Electromechanical register is $18 additional, installed. **Standard Instrument Corp, 657 Broadway, New York 12.**

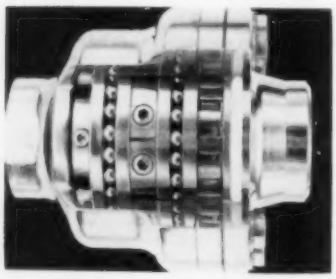
Circle 9, inside back cover



7 million:1 reduction . . .

is possible in a series of dc motors utilizing a gearbox, clutch and reset mechanism. Provides shaft rotation as slow as one revolution in 32 hr. Clutch will drive a load of 45 oz-in. and the return spring will exert up to 65 oz-in. torque. Reset mechanism returns the shaft to a zero position when motor power is interrupted. Unit withstands environmental requirements of MIL-M-8609 with an expected life of 5000 hr. **Dalmotor Div, Yuba Consolidated Industries, Inc, 1375 Clay Ave, Santa Clara, Calif.**

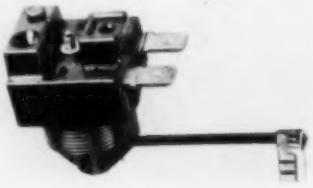
Circle 10, inside back cover



Cryogenic swivel joint . . .

permits liquid oxygen and other liquefied gases in transfer to circulate in thrust bearing races, achieving self-lubrication. Said to have improved temperature stabilization. Uniform spring tension against metal disk that in turn exerts pressure against Mylarseal is principal packing feature. Has Teflon dust seal. Joints under 2 in. dia will handle pressure to 2500 psi at temperatures from —320 F to 160 F. Joints over 2 in. currently handle pressures to 150 psi. Offered in sizes from ½ through 16 in. with flanged, threaded or beveled end connections for welding. **Chiksan Co, Sub of Food Machinery & Chemical Corp, 330 N Pomona Ave, Brea, Calif.**

Circle 11, inside back cover



Motor starting relays . . .

of the current-type are now commercially available in narrow differentials with stable pickup and drop-out ratings from as little as 1.01-amp max pickup (switch closed) and 0.86-amp min dropout (switch open) to as much as 24.4-amp max pickup and 20.3-amp min dropout. Relays are for single-phase ac hermetic refrigeration motors and in place of centrifugal starting switches on other single-phase ac motors of split-phase or capacitor-start type. Has bonded top-lay contacts for positive contact breaks, welded coil connections and contacts engineered for 1,000,000 operations at 7 amp, 115 v ac (max rating, 10 amp). Units are 1 $\frac{3}{4}$ x 1 $\frac{1}{2}$ in. and have one-screw mounting. Must be vertically mounted. Fully enclosed in phenolic cases. **Metals & Controls Corp, Spencer Thermostat Div, Attleboro, Mass.**

Circle 12, inside back cover

Purge valves . . .

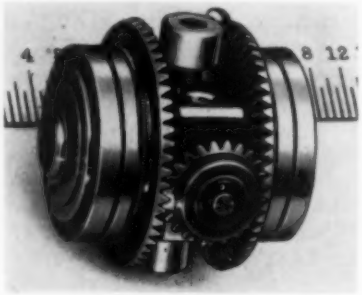
for bleeding gases or liquids from instrument and process lines are made in a variety of materials, including brass, Monel, stainless steel, aluminum, Zytel, Teflon and polyethylene. Removal passage is directed away from operator and a ball-and-seat arrangement seals tightly, but prevents ball from sticking after prolonged non-use. A knurled opening cap, permanently attached to body, opens, with finger pressure alone, a max of one turn, to give desired flow. Valves for installation in male and female pipe threads, AN fittings and compression fittings in sizes from $\frac{1}{8}$ to $\frac{1}{2}$ in. available for immediate delivery. **Nuclear Products Co, 15635 Saranac Rd, Cleveland 10.**

Circle 13, inside back cover

Self-closing relief valves . . .

are ASME-rated for temperature and pressure. Both have male inlet and $\frac{3}{4}$-in. female outlet connections. One is equipped with lever and short thermostat; the other with lever and extension thermostat. Both are bronze and have steam pressure discharge ratings of 1,028,000 btu/hr at 125-lb setting and AGA temperature water ratings of 750,000 btu/hr. **Watts Regulator Co, 10 Embankment Rd, Lawrence, Mass.**

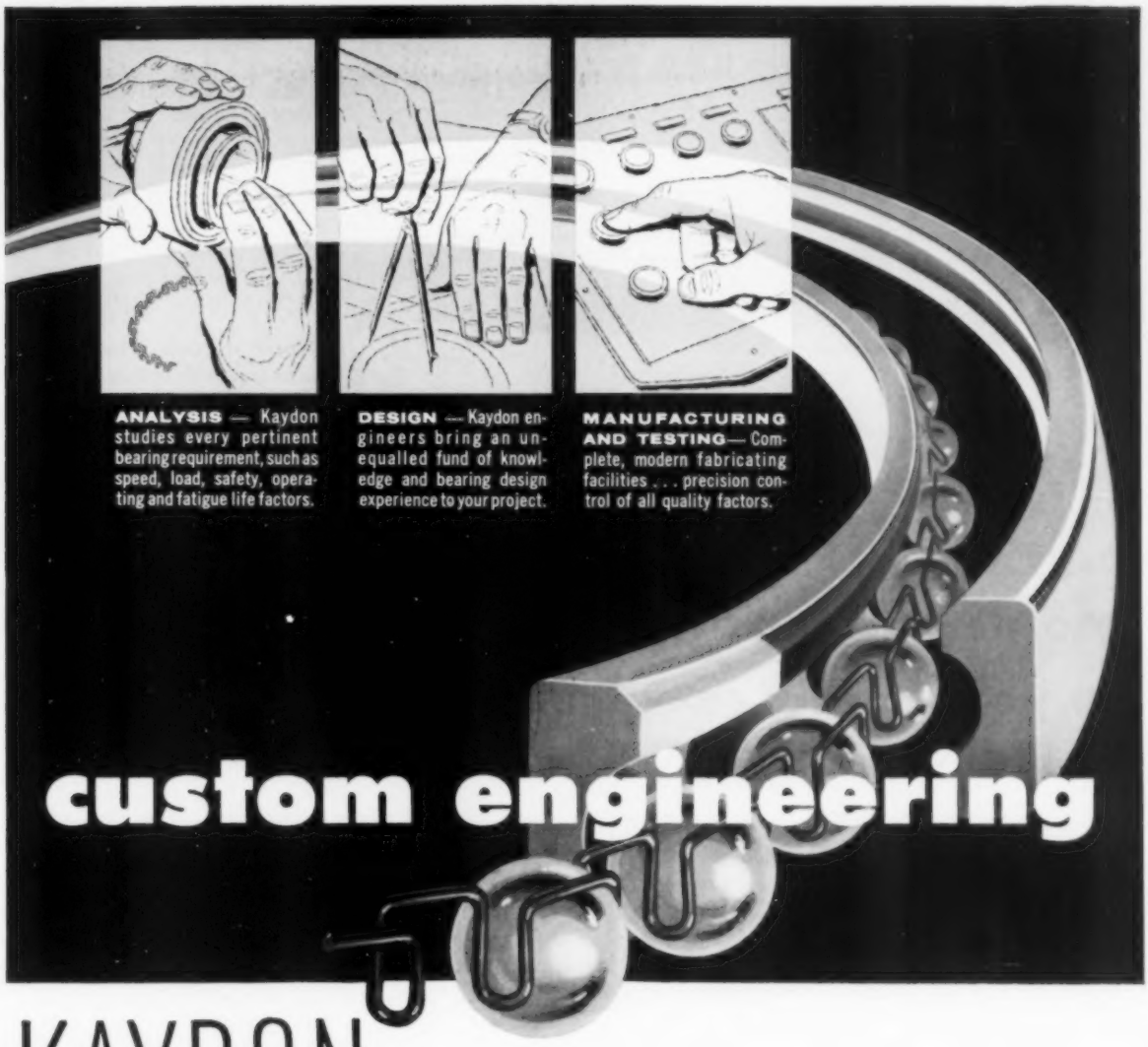
Circle 14, inside back cover



Two-pinion differential . . .

accepts two variables, in the form of angular shaft motion or shaft speed, as inputs; and adds or subtracts as required, resulting in output shaft rotation. Hollow spider shaft permits positioning of differential anywhere on output member. Hollow spider shaft unit is $\frac{7}{8}$ in. Has inertia

. . . CONTINUED ON PAGE 60



ANALYSIS — Kaydon studies every pertinent bearing requirement, such as speed, load, safety, operating and fatigue life factors.

DESIGN — Kaydon engineers bring an unequalled fund of knowledge and bearing design experience to your project.

MANUFACTURING AND TESTING — Complete, modern fabricating facilities . . . precision control of all quality factors.

custom engineering

KAYDON custom bearing designers can prove or improve your product

Why penalize product performance success with "make-do" bearings? Kaydon's long experience points out that standard bearings often *won't do*, aren't always efficient or economical.

Kaydon engineers creatively design, develop and manufacture special, modified, and standard ball and roller bearings. All-new Kaydon "idea bearings" or modified types will help you *prove* your new product designs; *improve* your redesigns. Kaydon can incorporate millionth's-of-an-inch precision, light weight or super-rugged construction to exactly match the bearing to your application.

Send us sketches or scale prints of your bearing problem. *There's no obligation.*

Typical Kaydon-developed special bearings

World's largest precision ball bearing (165") designed and built by Kaydon, rotates radar antennae.

World's thinnest radial ball bearing — Kaydon "Reali-Slim," 12.00" I.D., 12.500" O.D., .250" thick.

World's newest Thin-Shell Needle Bearing — for automotive and industrial use.

World's lightest large aircraft wheel bearings 9/16"cross section.

THE KAYDON ENGINEERING CORP.

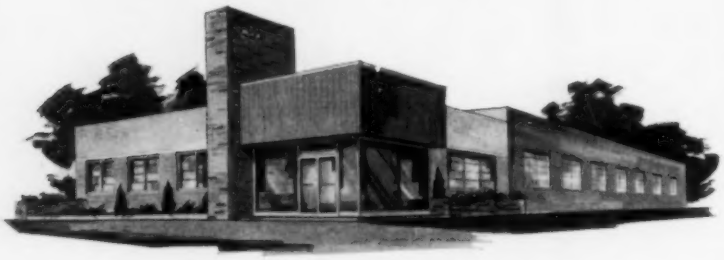
MUSKEGON, MICHIGAN

All types of ball and roller bearings — 4" inside diameter to 178" outside diameter . . . Taper Roller *Roller Thrust *Roller Radial *Needle Roller *Ball Radial *Ball Thrust Bearings.

K-581

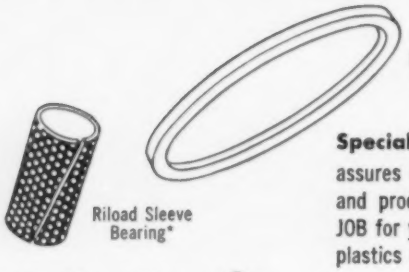
New Home of **MODERN INDUSTRIAL PLASTICS, INC.**

Expanding and Modernizing to Better Serve YOU...



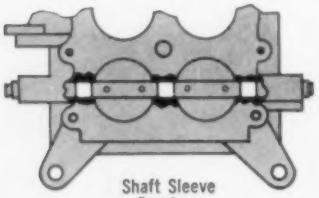
mip

molds and machines Teflon®
to your exact requirements



Ring Seals and Piston Rings

Riload Sleeve Bearing*



Shaft Sleeve Bearings

Cup Seals

Rilon Holl-"O" Ring*

Specialized Experience—
assures effective evaluation of designs and production parts that will DO THE JOB for you. MIP fabricates fluorocarbon plastics exclusively.

Design—
No possibility is overlooked in selecting the right combination of materials, design and manufacturing methods to yield the utmost in finished product performance and economy.

MIP'S Research • Development
—always at your command.

Production Facilities—
A new modern plant—to mold, machine, skive, blend and grind.

* Patent Applied For
® Registered by DUPONT

If it can be made of Teflon®, MIP can make it.

MODERN INDUSTRIAL PLASTICS, INC.

3337 NORTH DIXIE DRIVE • DAYTON 14 OHIO

of 0.075 oz-in.² with one end gear locked and input applied to the other gear. Max recommended gear input speed is 1200 rpm with max recommended static load of 6 in.-oz. Over-all length of the differential is 0.980 in. with a working circle of the entire package of 1.090 in. Weighs 1.06 oz. **Librascope, Inc, Commercial Div, 40 E Verdugo Ave, Burbank, Calif.**

Circle 15, inside back cover

Micronic in-tank filter . . .

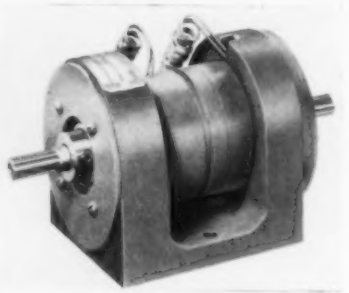
assembly is available in three models with rated flow rates of 7.5, 15 and 30 gpm. Resin-impregnated cellulose in accordion-pleated cylindrical configuration exposes a large surface area and effectively filters particles 10 microns or larger. Filter mounting structure is all-stainless steel and cannot contaminate filter assembly. Filtered flow rates of any amount can be obtained in hydraulic systems by using suitable combinations of filters arranged in parallel. **Kahn & Co, Inc, 547 Windsor St, Hartford 1, Conn.**

Circle 16, inside back cover

Weatherproof ac motor . . .

in all standard speeds in sizes from 1 through 250 hp is for applications where it is subjected to extreme moisture or the elements. An open motor that is said to exceed NEMA splashproof requirements, its external parts are corrosion-proof cast iron. Shaft openings are sealed by a shaft cap and slinger. Insulation system will not absorb water. Silicone sleeving, glass-mica slot liners and glass mat top- and mid-sticks contribute to waterproof quality. Heavy Formvar wire coils are coated by a thermosetting oil and water-resistant varnish, then sealed with a coat of enamel. **Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17.**

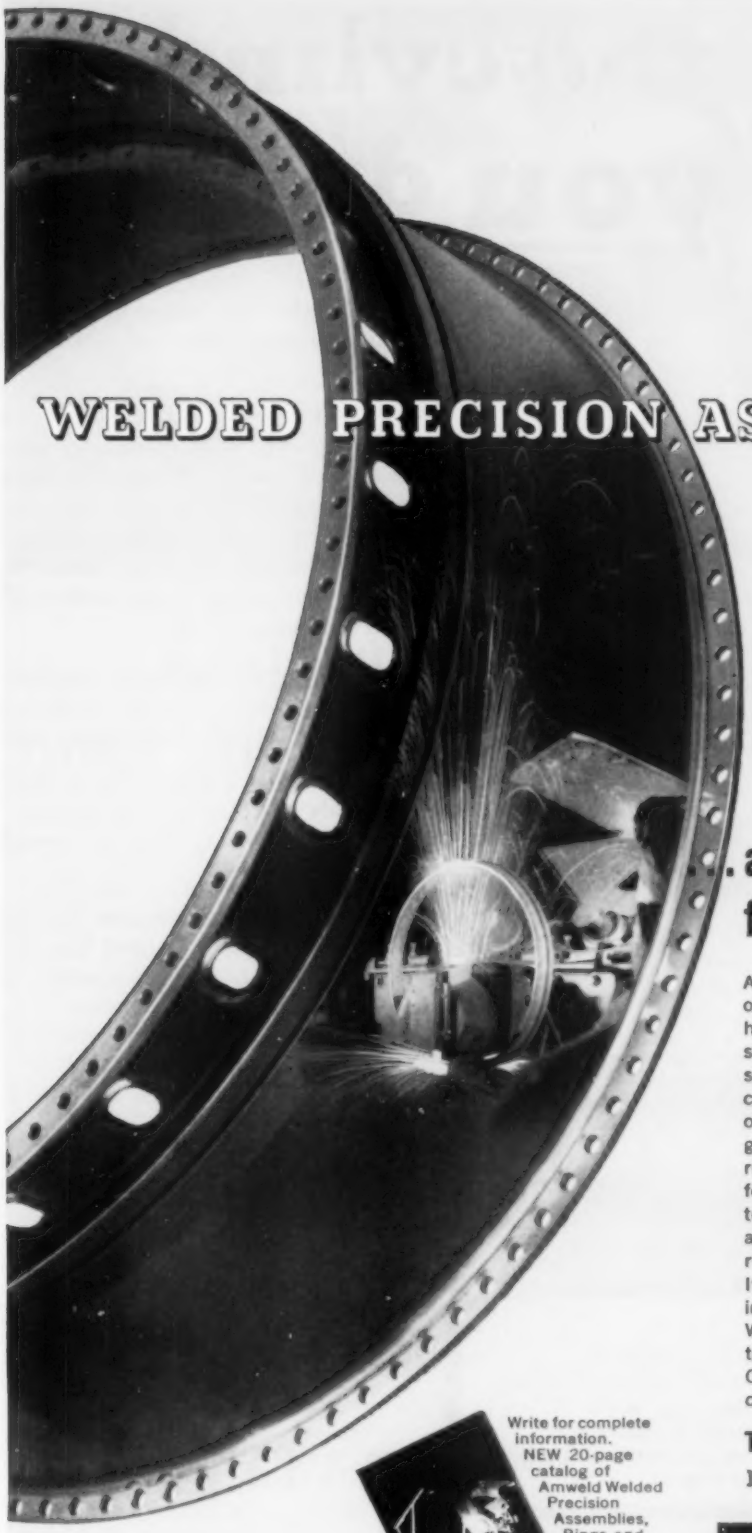
Circle 17, inside back cover



Magnet-set clutch-brake . . .

combinations are furnished with bearings, shaft and mounting stand in sizes 2, 3 and 5. Can be furnished with a common armature, splined to driving shaft, or with

(Continued on page 65)



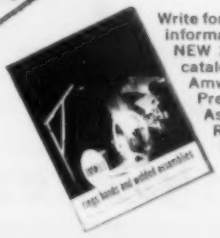
WELDED PRECISION ASSEMBLIES...

...a major AMWELD® fabricating service

American Welding has produced thousands of complicated welded assemblies, which have satisfactorily met the stringent specifications for aircraft, missiles, submarines and atomic reactors. These components are welded from a wide range of materials, including most stainless grades, titanium, aluminum, and heat-resistant alloys. Amweld's fabricating, forming, and machining facilities, plus testing and research departments, are available on a subcontract or research and development basis.

If you would like to obtain complete information on the capabilities of American Welding and how we can be of assistance to you — phone or write today.

Our local representative will be happy to call and discuss your requirements.



Write for complete information. NEW 20-page catalog of Amweld Welded Precision Assemblies, Rings and Bands.

The American Welding & Mfg. Co.

140 Dietz Road • Warren, Ohio

AMERICAN WELDING

ANNOUNCING

the cylinder you designed!

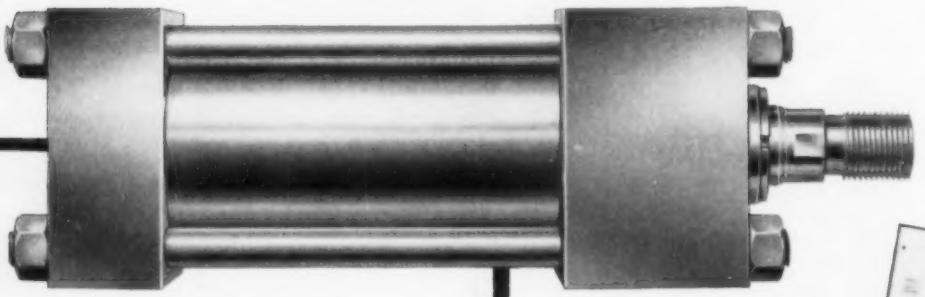
To save you and hundreds of other busy engineers time at the drawing board, Hanna representatives asked what you desired in hydraulic cylinder design.

You wanted a **stronger cylinder, preferably all steel with welded mountings.** You also wanted **tight sealing** at all pressures. These features were included in the Hanna Powrdraulic design. Some wanted **automotive piston rings;** others wanted **synthetic piston packings,** so the new flexible Powrdraulic design gives you a choice. You can also choose the **fast change cartridge gland** or the conventional **multiple lip packing** and you have a **choice of packing material** including Teflon* and silicone rubber.

Hydraulic cylinders should incorporate **industry standard mounting dimensions** and conform to Joint Industry Conference recommendations. These are included in the Powrdraulic design.

In addition, you want a cylinder that is **priced right,** with **prompt delivery** and **service available** in all parts of the country. You can have all this plus the assurance of quality when you specify Hanna Powrdraulic cylinders.

We will be happy to send you a catalog, and give you the name of your nearest Hanna Representative. You'll also find him listed in the yellow pages under "Cylinders" and in the alphabetical section of Thomas' Register.



Hanna Powrdraulic Hydraulic Cylinder
2000 psi and 3000 psi non shock — with generous factor of safety

Featuring — Pressure tightening tube seals
• One piece steel heads with welded mountings
• Double seal piston rings • Fast change cartridge gland
• Lubricated rod bearing

For full details write for Catalog 900

* Teflon is DuPont's registered trademark for its fluorocarbon resins.

Hanna Engineering Works

HYDRAULIC & PNEUMATIC EQUIPMENT • CYLINDERS • VALVES

1765 ELSTON AVENUE • CHICAGO 22, ILLINOIS

Look alikes... until you look closely!

At first glance, all microfilm images look pretty much alike. But enlarge them in a film reader or in paper facsimile form, and you'll see the difference:

In the image produced under the Recordak Precision Engineering Drawing System, you'll note the pinpoint definition throughout . . . the remarkably uniform background.

New Recordak techniques and controls, perfected in three years of research and development, have made this possible—a 35mm negative that faithfully reproduces every detail of the original drawing. Duplicates, made from this negative, in film or paper form, are just as accurate.

As a result, drawings and negative and positive prints of all sizes—old or new, clean or soiled—can be photographed without loss of detail on 35mm film. Ends need for costly, larger size films.

Mounting each of these Recordak images on its own file Filmsort aperture card provides an active drawing file that takes 95% less space . . . saves reference and filing time. Extra reference copies—on film or paper—can be made at lowest cost.

And, of course, this Recordak System can be correlated with existing mechanized filing and duplicating systems for greater savings!

FREE BOOKLET tells how Recordak System can work for you. "Must" reading for every engineer and draftsman. Mail coupon today.

"Recordak" is a trademark

RECORDAK

(Subsidiary of Eastman Kodak Company)

originator of modern microfilming
—now in its 31st year

MAIL COUPON TODAY

JJ-9

RECORDAK CORPORATION
415 Madison Avenue, New York 17, New York

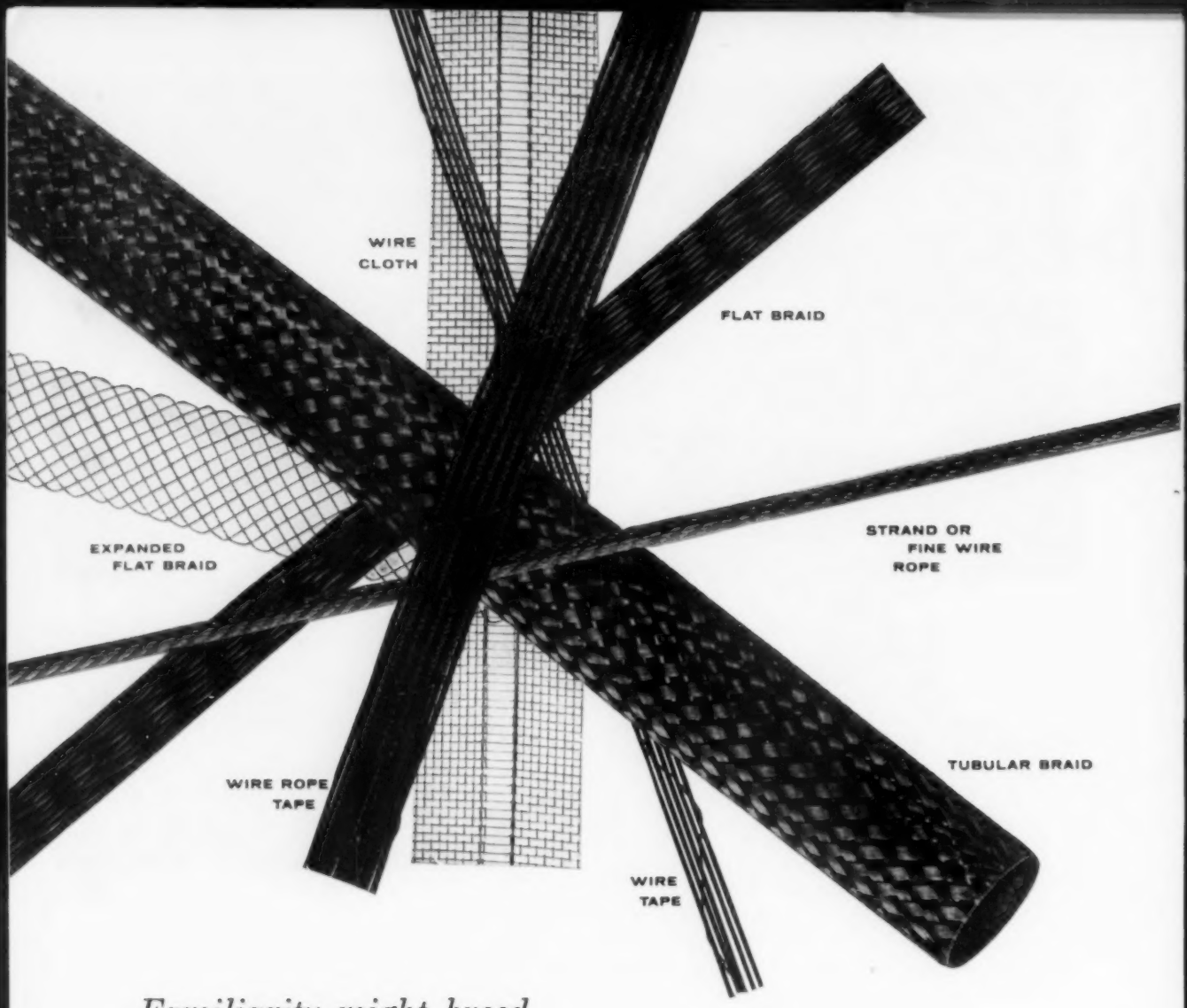
Gentlemen: Send free booklet describing new Recordak Engineering Drawing System. No obligation whatsoever.

Name_____

Company_____ Position_____

Address_____

City_____ State_____



Familiarity might breed

NEW PRODUCT IDEAS!

The wire fabrications shown here, highly developed specialties of National-Standard, are available in many types and sizes. Each can be produced in any metal that can be drawn into wire.

These materials are used in numerous products today for many different reasons . . . for strengthening, stiffening, protection, safety, decoration, filtering, screening, heat or electrical conductivity, grounding, etc., etc.

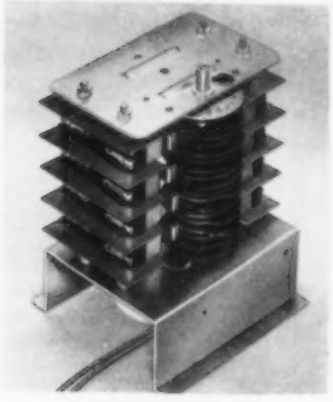
Can one of these materials meet a present or new product requirement of yours? You'll never find an organization more cooperative or better qualified to help you fully explore any such ideas. Just get in touch with National-Standard, Niles, Michigan.

NATIONAL STANDARD

DIVISIONS: NATIONAL-STANDARD, Niles, Mich.; *tire wire, stainless, music spring and plated wires, flat and tubular braid and wire cord*
WORCESTER WIRE WORKS, Worcester, Mass.; *music spring, stainless and plated wires, high and low carbon specialties* • **REYNOLDS WIRE, Dixon, Ill.**; *industrial wire cloth*
WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • **ATHENIA STEEL, Clifton, N. J.**; *flat, high carbon spring steels*

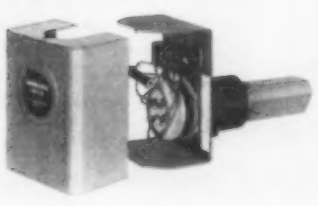
a common hub with separate armatures for the clutch and brake, in order to key hub to shaft, allowing zero backlash. Torque ranges from 25 in.-oz to 175 in.-lb on both clutches and brakes. Clutch and brake coils are set up for dc operation and can be wound for voltages up to and including 90 v. **Stearns Electric Corp, 120 N Broadway, Milwaukee 2.**

Circle 18, inside back cover



Adjustable cycling timers . . . with switching accuracy of 1½° for any one circuit, 3° between two circuits, are for one to eight independent circuits. Both throws of each SPDT load switch are controlled by separate cams, independently adjustable through 180° with a small wrench. Cam setting is indicated on a dial in percent of full cycle time. Cycle times from 6 sec to 48 hr are offered. One model provides from one to three load switches; another from four to eight. Load switches are rated for 20 amp at 125 or 250 v ac; the motor for 115 to 230 v, 25, 50 and 60 cps. **Cramer Controls Corp, Centerbrook, Conn.**

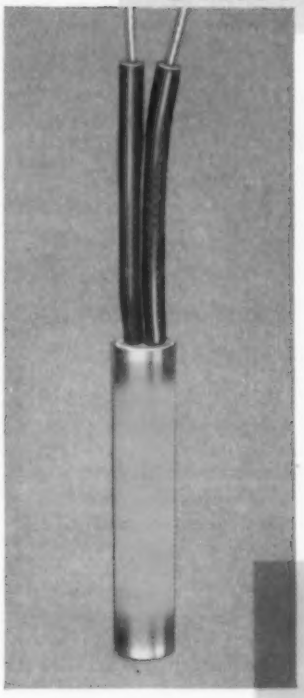
Circle 19, inside back cover



Liquid-level switch . . . operates when rise or fall of liquid actuates one of two thermostats and a heater inside probe section. When liquid rises to probe, temperature drop completes heater circuit through one thermostat and trips switching thermostat. When liquid falls away from probe, switching action is reversed. Auxiliary heater prevents

(Continued on page 66)

FIREROD®
CARTRIDGE HEATER



OPERATED
IN OPEN AIR
AT 1800° F.
FOR 720 HOURS
AT 90 WATTS sq. in.

5 times more heat than any standard cartridge heating unit...plus longer life

ACTUAL TESTS – not just claims – are proving the superiority of the new WATLOW FIREROD Cartridge Heating Unit.

Take, for example, the endurance test headlined above: a FIREROD unit, rated at 115 v., 250 w., and measuring 2¼" long x ½" dia., has been operated at a sheath temperature of 1800° F. for more than 720 continuous hours. A conventional unit of similar size would last *just minutes,* even though rated at much lower wattage!

In actual use, this means you can operate a WATLOW FIREROD at higher watts densities and temperatures and still get long life – or operate at normal watts densities and temperatures and get greatly extended life.

FOR ADDITIONAL TEST INFORMATION, *operation data, style information, etc., write for your* ***FREE Illustrated Watlow Bulletin.***

WATLOW
ELECTRIC MANUFACTURING CO.
1392 Ferguson Avenue
Saint Louis 14, Missouri

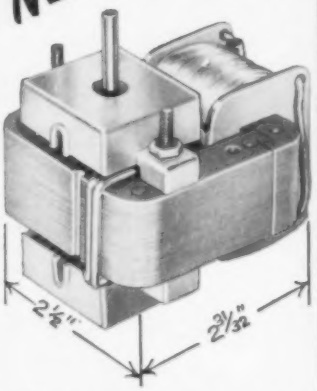
GENERAL INDUSTRIES

Smooth Power

AC MOTORS

1/1800 H.P. to 1/35 H.P.

NEW! 2-POLE, SHADED-POLE MOTOR 1/550 HP to 1/50 HP



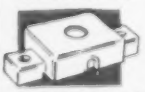
Designed and Constructed with Features That Insure

EXTRA YEARS OF SERVICE

When exceptionally long service is a must, you can rely on GI's new Model H, 2-pole, shaded-pole motor. The Model H is constructed with many outstanding features that assure thousands of EXTRA HOURS of service under the most adverse operating conditions. Available in nine models that cover a wide range of applications.

OIL CAPACITY MANY TIMES GREATER THAN CONVENTIONAL MOTORS Oversized oil bearing reservoirs hold considerably more oil and wicking assuring more efficient lubrication over a longer period of time.

REVOLUTIONARY METHOD OF PACKING THE OIL WICKING A unique new method of packing the oil wicking assures equal oil distribution at all times resulting in quieter operation and longer, trouble free life.



DIE-CAST BEARING BRACKET This new "H" Motor design includes a rugged die-cast bearing bracket that insures permanent precision alignment and adds to the over-all durability.

Write today for catalog sheet and quantity-price quotations.

THE GENERAL INDUSTRIES CO.

DEPARTMENT GK • ELYRIA, OHIO

moisture accumulation. Has no moving parts and requires no valves or equalizer lines. Hermetically sealed. Steel construction is standard. Fits into a 1¼-in. EH coupling, projecting into a vessel or header at level to be controlled. Switching-circuit capacity is 10 amp at 115 v, 5 amp at 230 v. Standard operating liquid temperature range is —10 to —60F, 30 to —20 F or 70 to 20 F in normally open or normally closed models. Switch has list price of $92. J E Watkins Co, 307 Lake St, Maywood, Ill.

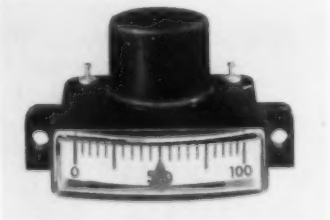
Circle 20, inside back cover

Thin-section ball bearings . . . in 16 sizes, with bores from ⅜ to 3⅛ in., have light, one-piece retainers with max ball complements and continuous race shoulders without filling slots. Bearings are available in 52100 bearing steel or 440C stainless steel. Standard retainer is fiber-reinforced pressure-molded phenolic, although stamped one-piece stainless steel retainers are available. Dimensions to standards for AFBMA B-500 series. Split Ballbearing, Div of MPB, Inc, Lebanon, NH.

Circle 21, inside back cover

Subminiature switch . . . is said to be conservatively rated at 100 milliamp with a life expectancy of more than 1 million operations. Silver contacts are SPST, normally closed. Pushbutton switch is 0.97 in. long, including solder-type terminals. Max dia is 0.37 in. Button caps in 10 colors are available as an accessory. Grayhill, Inc, 561 Hillgrove Ave, La Grange, Ill.

Circle 22, inside back cover



Edgewise meter . . . for control panel applications where space is limited but large display is required, has clear Plexiglas front and large triangular

(Continued on page 68)

Boost production . . . cut fatigue with

Westinghouse Air Circuitry*

***Westinghouse Air Circuitry** is the application of pneumatic control to industrial production operations — a proven method of stepping up machinery output . . . increasing operator efficiency. These pneumatic devices are low in cost . . . easy to install . . . extremely accurate and reliable.

"H" CONTROLAIR® VALVES:

3- and 4-way directional valves—accurate pressure control in small increments—hand, foot, knob, or cam operation—maximum delivery pressure: 60, 100 psi—port sizes: ¼" ips—maximum operating temperature: 200°F.

THREE-POSITION CYLINDERS:

noncushioned—3 stroke positions—foot and swivel mounted—2"-6" in diameter—maximum operating pressure: 250 psi.

MULTI-POSITION CYLINDERS:

noncushioned—4, 5, or 7 stroke—small diameter—tough, corrosion-resistant construction—maximum operating pressure: 250 psi.

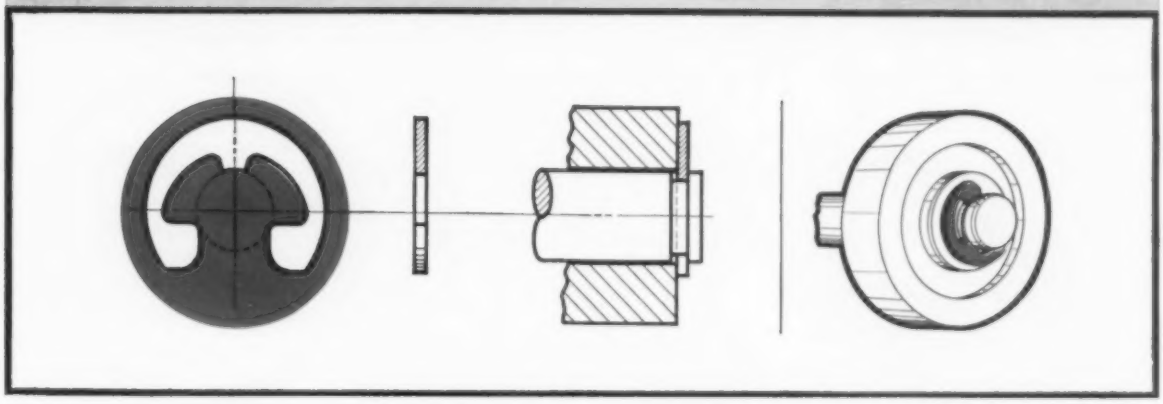
Consult your nearest Westinghouse Air Brake Distributor. He's listed in the classified phone directory under "Cylinders: Air."

Westinghouse Air Brake COMPANY

Industrial Products Division

WILMERDING PENNSYLVANIA

New Waldes Truarc Reinforced "E-ring" Provides 5 Times More Gripping Power, 50% Higher RPM Limits Than Conventional E-Type Rings



The new Waldes Truarc Series 5144 is a radially-installed reinforced "E-ring." It is designed for use in assemblies where the ring is subject to strong push-out forces resulting from heavy vibration and shock loads, high rotational speeds or relative rotation between the retained parts.

Series 5144 provides the following application advantages over conventional E-type fasteners:

1. **GREATER GRIPPING STRENGTH**—approximately five times greater than conventional "E-rings" of the same metal and thickness.
2. **HIGHER RPM LIMITS**—approximately 50% higher in most sizes.
3. **POSITIVE LOCKING IN THE GROOVE**—large corner radii or chamfers can be accommodated without separator washers.
4. **LOWER GROOVE COSTS**—because recommended groove tolerances have been increased, machining grooves for the series 5144 is less expensive.
5. **WIDER APPLICATION**—because series 5144 rings made of aluminum are stronger than conventional "E-rings" made of steel, the fastener may be used in applications where corrosion resistance or weight are factors.

Truarc Series 5144 Reinforced "E-rings" are available for shaft diameters from 3/32—7/16 in. in carbon spring steel, stainless steel, beryllium copper, aluminum, and phosphor bronze. They are available stacked on rods for high speed installation with Truarc applicating and dispensing equipment.

As in all Truarc rings, you get statistically controlled quality from engineering and raw materials to the finished product. Complete selections are available from leading OEM distributors in 90 stocking points throughout the U. S. and Canada. Design Engineering Service is available to you. Send us your blueprints. Let our Truarc engineers help you solve design, assembly and production problems... without obligation.

SEND FOR FREE SAMPLES **AND ENGINEERING DATA**

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

☐ Please send me sample Reinforced "E-rings." (please specify shaft size)_____

☐ Please send me Engineering Data Sheet

Name_____

Title_____

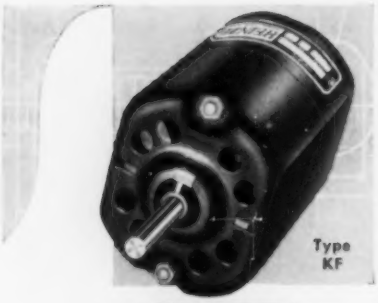
Company_____

Business Address_____

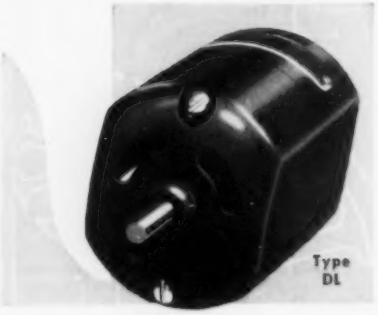
City_____ Zone_____ State_____

PN090

Consult the Yellow Pages of Your Telephone Directory for Name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."



put HEINZE in your designs



VERSATILITY...IN HEINZE UNIVERSAL MOTORS

Variable speed . . . high starting torque . . . reversibility . . . high output . . . you get them all in Heinze Universal Motors. Horsepower ratings are from 1/15 hp to 1/50 hp, with load speeds of 5000 to 7500 rpm. Normally designed for 115V AC/DC, CW, CCW or reversing. Other voltages are available. Internal or external brushes may be supplied. Type DL has die cast housing. Broad applications include sewing machines, business machines, movie projectors, electric organs, small hand tools.

You have a wide choice of models from the comprehensive line of Heinze sub-fractional horsepower motors and blowers. Send us your product and specifications. Heinze Engineers will adapt a motor, at no obligation. Or write for catalog.

HEINZE ELECTRIC COMPANY
685 Lawrence St., Lowell, Mass.

Sub-Fractional Horsepower Motors and Blowers

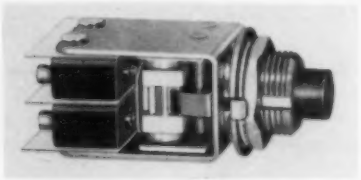
pointer on a scale $1\frac{7}{16}$ in. long. Uses coaxial type mechanisms. Available in standard current and voltage ranges, 100 milliamp to 1 amp and 1 to 300 v. Weighs $1\frac{1}{2}$ oz. **Marion Electrical Instrument Co, Grenier Field, Manchester, NH.**

Circle 23, inside back cover

Miniature relay . . .

operates on dc coil signals of 20 to 100 milliw. Standard units are SPDT or DPDT. Contact rating with resistive load at 28 v dc or 115 v ac is 3 amp with silver contact; 0.5 amp with palladium or gold alloy contacts. Contact life is said to be 100,000 operations min. Operates in temperatures of —67 to 212 F. Withstands shock to 50 g, vibration to 10 g, from 10 to 500 cps. Hermetically sealed enclosures are available. **Comar Electric Co, 3349 W Addison St, Chicago 18.**

Circle 24, inside back cover



Alternate-action actuator . . .

is suitable for any configuration of subminiature basic switch that conforms to military specifications. Designed for alternate-action pushbutton applications, on panel mounting for instruments and components for ground-support equipment. Plunger, 0.323 in. dia, is standard black. Dimensions are $\frac{13}{16}$ x $\frac{5}{16}$ x $1\frac{3}{4}$ in. high; $\frac{13}{32}$-in. bushings for panel mounting. Contacts are SPDT operating on 60-g pressure. Rated for a service life of 150,000 contacts at 125 to 250 v ac, 2.5 amp; 50,000 contacts at 30 v dc, 2.5 amp inductive. Small quantities from stock; large orders, 2 to 3 wk. **Electrosnap Corp, Switch Div, 4230 W Lake St, Chicago 24.**

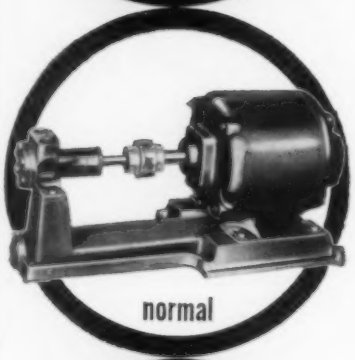
Circle 25, inside back cover

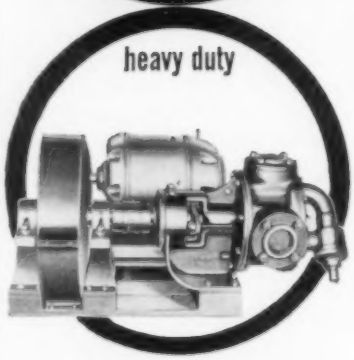
Pneumatic release valve . . .

can vent pressure in increments of about 6 psi. Air pressure enters supply port, forcing diaphragm against exhaust port and closing it. Also deflects rim of diaphragm, opening direct passage to delivery port, which is always open. When air pressure at supply port is reduced 5 psi min, pressure differential lifts diaphragm from exhaust port and seats it on supply port, opening exhaust and allowing air to flow freely from delivery port to atmosphere; also closing supply port. If valve pressure drops about 1 psi

(Continued on page 71)

What job do you have for a VIKING PUMP?





Sizes From 2/3 to 1050 G. P. M. Capacities

There is a Viking positive displacement pump for most industrial pumping requirements . . . probably yours. If you need fast, self-priming along with positive, smooth delivery, Viking Pumps are your answer — whether liquids are thin or thick.

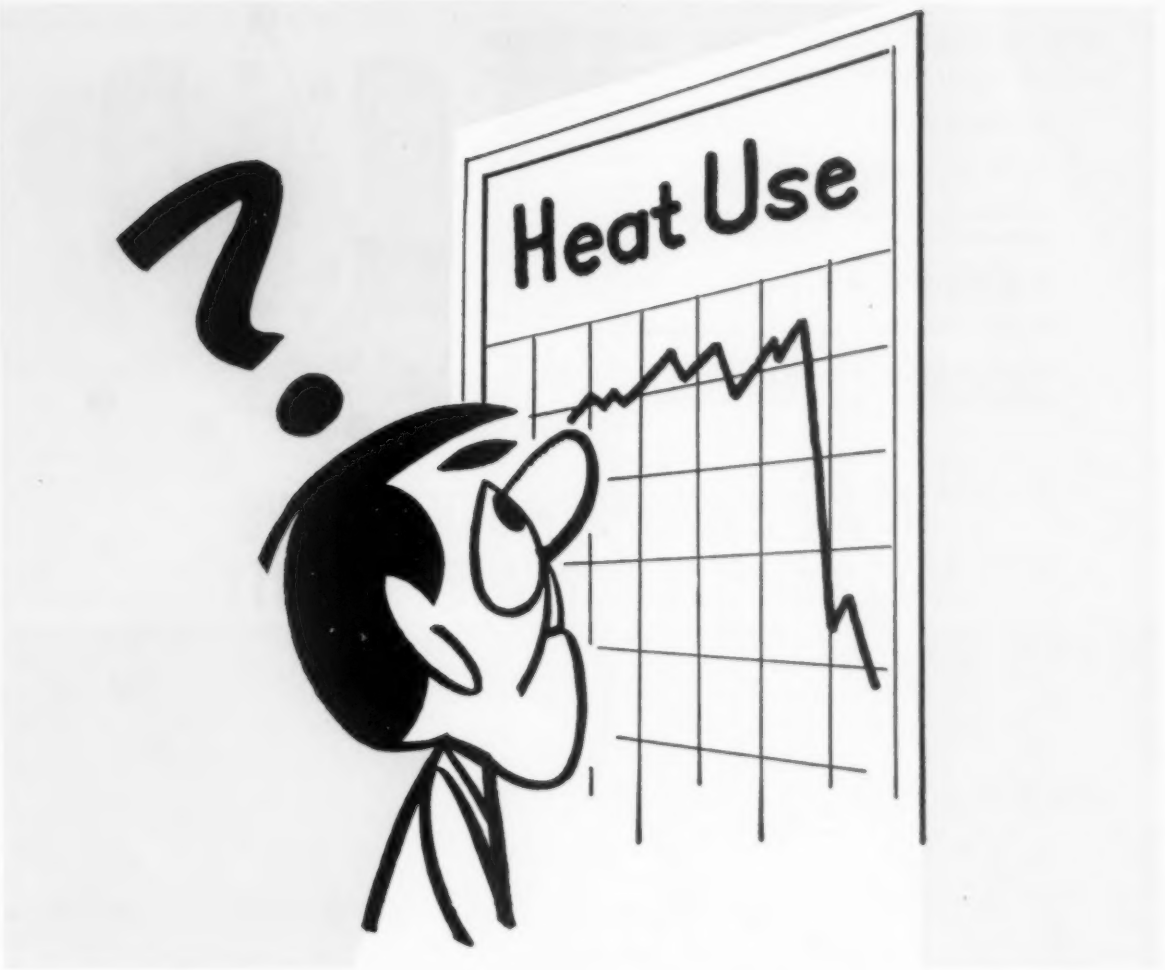
In the Viking Pump line there are 750 cataloged models in 20 sizes, with additional thousands of specially built pumps available. This wide selection assures you of the right pump to fit your needs.

So, install Viking Pumps! Save space; Save dollars! Save installation and operating time! And let one of the simple Viking "gear-within-a-gear" pumps do your job the way you want it done.

Send today for Catalogs Section BX and CX

VIKING PUMP COMPANY

Cedar Falls, Iowa, U.S.A.
In Canada, it's "ROTO-KING" Pumps
See Our Catalog in Sweet's Product Design File



THE CASE OF THE PUZZLED ENGINEER

(A Cold Bonderite* Story)

The plant heating engineer, wondering at the diminished demand on his heating plant, set out through the plant to find the cause. All was normal until he met the finishing superintendent. "Haven't you heard?" asked that happy gentleman. "We've installed Cold Bonderite* in our finishing line. Steam use is down 90% and water use is down 50%!"

*"Cold Bonderite" is the commonly used term for a phosphate coating system developed by and exclusive with Parker Rust Proof Company. Its use is saving many manufacturers thousands of dollars a month.

Since 1914— leader in the field

PARKER RUST PROOF COMPANY
2179 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

*Bonderite, Bonderlube, Parco, Parco Lubrite, —Reg. U.S. Pat. Off.

TYPICAL SCHRADER SIMPLIFIED VALVE DESIGN

. . another reason why your air system installations will perform best.

A—Mounting holes always conveniently located.

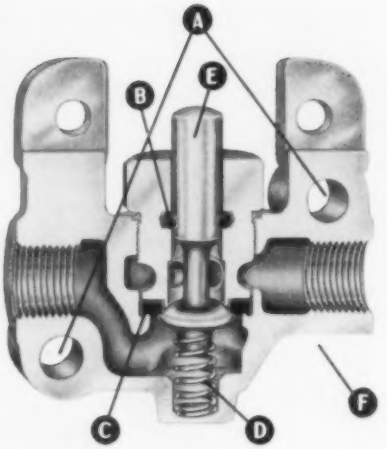
B—"O" rings used for surest airtight seal.

C—Oil-resistant synthetic rubber used in washers for positive leakproof seat.

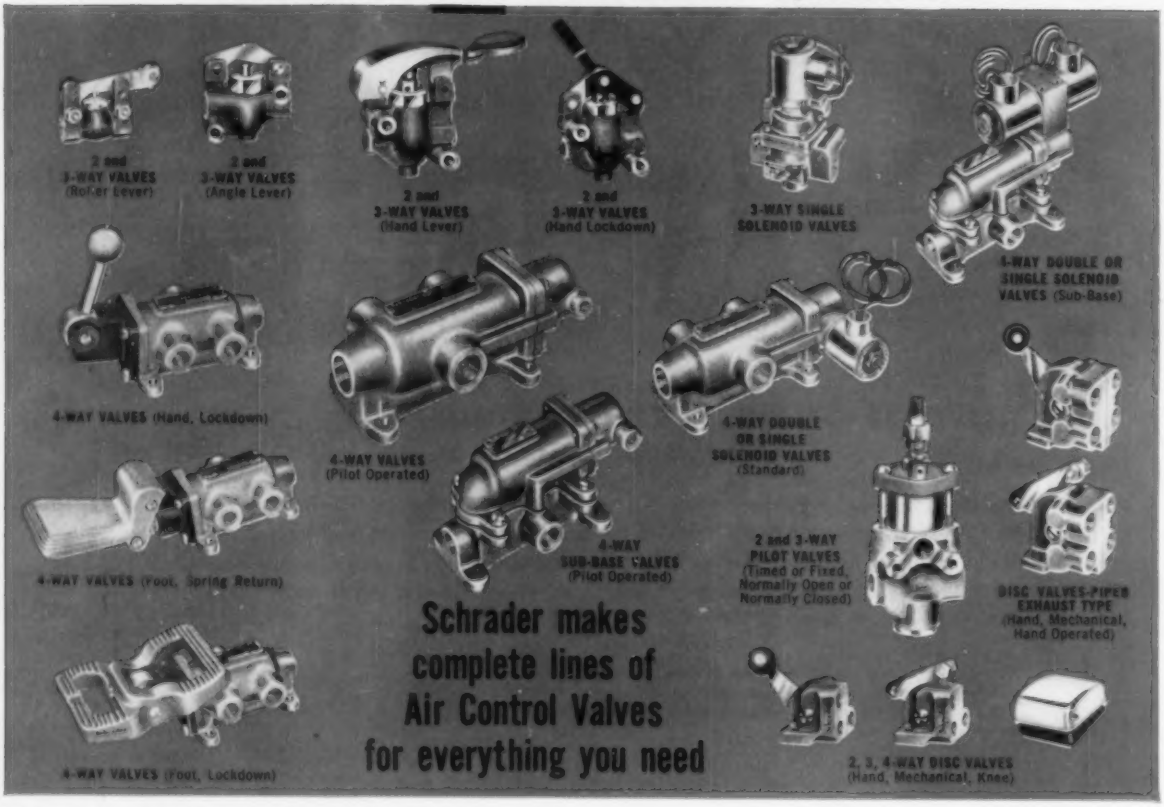
D—Stainless steel springs: rust resistance, longest service life.

E—Sturdy plated plungers, quick acting, smooth-operating.

F—All parts designed for greatest air flow, longest life and simplicity of replacement and interchangeability.



INSIDE EVERY SCHRADER VALVE YOU CAN SEE SCHRADER QUALITY


2 and 3-WAY VALVES (Roller Lever)
2 and 3-WAY VALVES (Angle Lever)
2 and 3-WAY VALVES (Hand Lever)
2 and 3-WAY VALVES (Hand Lockdown)
3-WAY SINGLE SOLENOID VALVES
4-WAY DOUBLE OR SINGLE SOLENOID VALVES (Sub-Base)
4-WAY VALVES (Hand, Lockdown)
4-WAY VALVES (Pilot Operated)
4-WAY DOUBLE OR SINGLE SOLENOID VALVES (Standard)
4-WAY SUB-BASE VALVES (Pilot Operated)
4-WAY VALVES (Foot, Spring Return)
2 and 3-WAY PILOT VALVES (Timed or Fixed, Normally Open or Normally Closed)
DISC VALVES-PIPED EXHAUST TYPE (Hand, Mechanical, Hand Operated)
4-WAY VALVES (Foot, Lockdown)
2, 3, 4-WAY DISC VALVES (Hand, Mechanical, Knee)
Schrader makes complete lines of Air Control Valves for everything you need

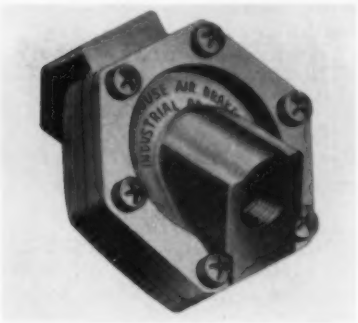
Plus hundreds of Air Cylinders and accessories for every need

Send for Schrader Catalog on full line of air control products.

Schrader® a division of SCOVILL

A. SCHRADER'S SON • *Division of Scovill Manufacturing Co., Inc.*
477 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS



below supply port pressure, diaphragm is moved so it seats on exhaust port, stopping further flow of air. Has ¾-in. IPS tapped ports. Max operating temperature is 200 F; 250 psi is max operating pressure. Valve is 3 in. dia x 2⅜ x 2⅛ in. $5.25 list, FOB Wilmerding. **Industrial Products Div, Westinghouse Air Brake Co, Wilmerding, Penna.**

Circle 26, inside back cover

Flow-rate indicator . . .

uses O-ring construction to seal metering tube, eliminating packing glands and stuffing boxes. Simplified design needs minimum adjustment and maintenance. One-piece bronze body provides strength with least weight. Three meter sizes cover flow ranges from fractional to 26 gpm of liquid or 65 cfm of gas. **Fischer & Porter Co, 797 Jacksonville Rd, Hatboro, Penna.**

Circle 27, inside back cover

Drafting machine . . .

attaches to any drawing board. Clip angles secure guide rail and blade is held in positive alignment by ground radial ball bearings that are double-shielded and grease-packed. Plated to prevent rusting. Snaps on and off for cleaning or change of paper. Made of plastics and aluminum. Base price is $27.95 for a 36-in. blade; $1 for each additional 6 in. length. Money-back guarantee within 30 days. **Align-O-Matic Co, 216 S 5th St, Richmond, Va.**

Circle 28, inside back cover

Plastic metal kit . . .

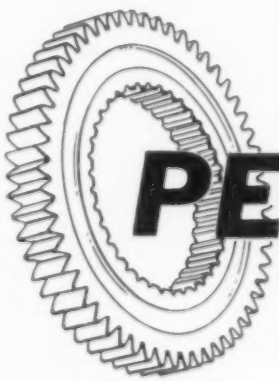
contains 1 pt of clear epoxy, five jars of powdered metals. Powders can be mixed with epoxy to meet various bonding needs, or epoxy can be used alone to bond glass, china, plastic or wood. Kit augments plastic aluminum package and includes brass, zinc, iron and stainless steel. Priced at $15. **Carl H Biggs Co, Dept 43, 2255 Barry Ave, West Los Angeles 64.**

Circle 29, inside back cover

WHY TRY TO SOLVE YOUR GEAR PROBLEMS ALONE?

PERKINS can custom-cut a precision gear to fit your exact needs...make you a gear that guarantees full capacity and trouble-free performance. Many gear-makers promise a precision gear — Perkins delivers precision . . . always. Fifty-two years of gear-making for aircraft, automotive and instrument manufacturers assure top quality. Extensive facilities, modern equipment, rigid production and quality controls produce gears consistently uniform in tolerance with a burr-free micro finish. Perkins quality eliminates production delays and costly rejects for you . . . Perkins gears wear longer, cost you less in the long run. Ask us to quote on your next gear requirement. Then judge for yourself.

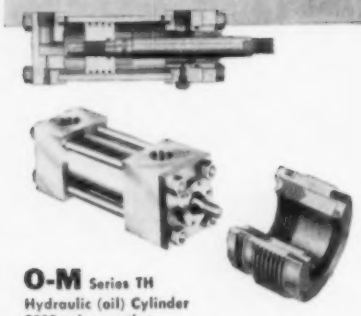
YOURS ON REQUEST
Folder showing custom gears Perkins has made (from various materials) for aircraft, automotive, precision instruments, home appliances, portable and machine tools, and other products. Includes Perkins facilities for producing various gear types and sizes. *Write today.*



PERKINS
MACHINE AND GEAR CO.

Dept. 32, West Springfield, Mass.
Telephone: REpublic 7-4751

DESIGNED FOR HEAVY DUTY BUILT TO TAKE IT!



O-M Series TH
Hydraulic (oil) Cylinder
2000 psi operation
3000 psi Non-Shock
available in 1½ to 8" bores
Meets JIC Standards

Every engineering and construction detail of the improved O-M Tie-rod Hydraulic Cylinder adds to its overall operating efficiency under heavy work loads, assuring maximum smooth performance with minimum maintenance. It is ruggedly constructed of heavy walled, seamless steel tubing microhoned to minimize friction. The rolled steel heads are recessed to confine the tube, prevent breathing and to provide additional protection against leakage under the most severe conditions. Heads can be rotated independently at 90° intervals for convenient port location. The piston rod is of stress relieved, high tensile steel, hard chrome plated turned, ground and polished. The rod gland cartridge that is threaded for quick, easy removal, is accurately piloted in rod head to assure perfect alignment, also serves as pilot for cylinder mounted on rod end. Rod gland contains extra long bronze rod bearing for maximum support of piston rod.

Vee type, non adjustable, self compensating, rod gland packing provides multiple lip seal. Cartridge "O" ring, with leather back up furnishes a positive seal. Rod wiper or interchangeable metallic scraper prevent dirt from entering cylinder on "in" stroke. A complete selection of mounts is available.

These and many other features are described in detail in our latest catalog No. 105. Write for your copy TODAY or consult your local O-M representative.

ORTMAN-MILLER MACHINE CO
15 143rd Street, Hammond, Indiana
☐ Have representative call
☐ Send Bulletin 105

Name_____ Position_____
Company_____
Address_____
City_____ Zone_____ State_____

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 74.

FASTENER APPLICATION—Pocket size booklet, 16 pp. Data on selecting right grade of bolt, proper torque, bolt stresses; calculating proper bolt loading, tightening limitations, threads and protective coatings. A section is devoted to selection of tapping screws. Charts show safe load curves and torque curves. Russell, Burdsall & Ward Bolt & Nut Co, 101 Midland Ave, Port Chester, N.Y.

Circle 30, inside back cover

EPOXY GLASS LAMINATES—Manual, 21 pp. Contains test values and curves, as well as specification data, on clad and unclad laminates for printed and other circuitry. Gives test data on bond strengths, flexural strength, dielectric breakdown and other test values based on MIL and NEMA specs. Also includes temperature rise and voltage test curves. Mica Corp, 4031 Elenda St, Culver City, Calif.

Circle 31, inside back cover

VACUUM METALLIZING COATINGS—Brochure, 16 pp. Coating-application procedures as well as the coating used are described. Includes physical properties and characteristics. Bee Chemical Co, 12933 S Stony Island Ave, Chicago 33.

Circle 32, inside back cover

LOW-ALLOY STEEL—Booklet, 20 pp. Describes development of three grades of alloy and resultant broadening of application. Gives mechanical characteristics of each grade with illustrations of actual applications. Kaiser Steel Corp, Engineering Sales Dept, PO Box 58, Oakland 12, Calif.

Circle 33, inside back cover

SPEED-MEASURING INSTRUMENTS—Bulletin 35, 20 pp. Catalogs a variety of ranges and types for applications in all industries. Gives description, operation and specifications for each unit. Illustrated by photos, line and dimensional drawings. With price list. James G Biddle Co, 1316 Arch St, Philadelphia 7.

Circle 34, inside back cover

SELF-LOCKING SETSCREWS—Selector chart. Shows over 1000 applications for locking device. Illustrates many locking actions and describes operation of each. Set Screw & Mfg Co, Bartlett, Ill.

Circle 35, inside back cover

FINISHED BORE SPROCKETS—Bulletin 3, 4 pp. Lists 99 sizes, 433 different boxes, prices. Acme Chain Corp, Holyoke, Mass.

Circle 36, inside back cover

CONTINUOUS SLEEVE FLEXIBLE COUPLINGS—Brochure 502, 4 pp. Design and application data is given. Discusses advantages, proper selection, step-by-step assembly and disassembly instructions and recommended lubrication specifications. Mechanical Power Transmission Div, Zurn Industries, Inc, Erie, Penna.

Circle 37, inside back cover

STAINLESS STEEL FLEXIBLE HOSE—Data sheet SSDS-562, 4 pp. Gives information on pressure capabilities, flexibility, suggested uses, formulas for determining best lengths in tabular form. Threaded and flanged end fitting connections are diagrammed. Allied Metal Hose Co., 3797 Ninth St, Long Island City 1, N. Y.

Circle 38, inside back cover

TRANSMISSION BELTING—Folder, 4 pp. Gives specifications and data for selection and use. Discusses belting with outside cover of split chrome-tanned leather and belting with woven fabric cover. Coriamid Inc, 41 Commercial St, Fitchburg, Mass.

Circle 39, inside back cover

1/20 to 200-HP MOTORS—Bulletin SB-175, 4 pp. Current list prices, dimensional data and drawings, standard modifications, slide base dimensions with diagrams and adapter information. Marathon Electric Mfg Corp, Wausau, Wis.

Circle 40, inside back cover

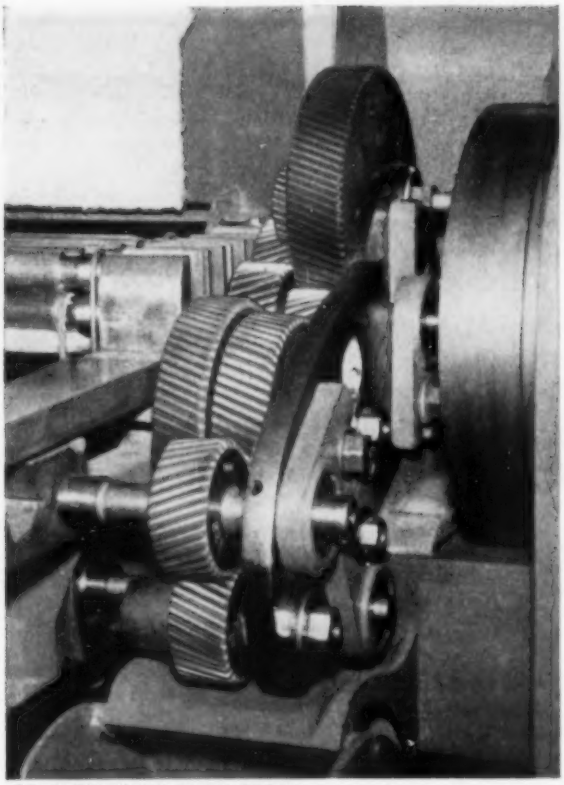
ADAPTERS FOR HOSE FITTINGS—Catalog 4490, 12 pp. Presents expanded line of adapters for reusable fittings. With photos, dimensional drawings and specification tables. Parker Fittings & Hose Div, Parker-Hannifin Corp, 17325 Euclid Ave, Cleveland 12.

Circle 41, inside back cover

FLUID POWER CIRCUITS—Booklet, 28 pp. Revised edition meets new requirements. Circuits cover sequencing, semi-automatic and automatic cycling, dual pressure systems, safety systems, skip-

(Continued on page 74)

Put strength, long life, silence into gears and couplings with CDF Celoron® molded plastics



CELORON-TO-CELORON GEARS in drawing rolls made by Ideal Industries, Inc., Bessemer City, N. C. These are helical-cut gears—the toughest to machine, requiring the toughest material. Celoron is it. Other Celoron parts for this application are shown below, top right.

WORK MIRACLES IN MACHINERY with this amazing golden phenolic material! Celoron gears help eliminate noise and reduce wear on mating metal gears. Even the roughest-used helicals last . . . and last . . . and last.

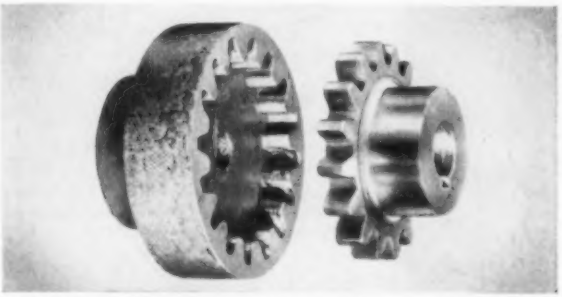
HIGH MECHANICAL STRENGTH. Typical Celoron strengths: tensile, 6,500 psi; flexural, 10,000 psi; compressive, 25,000 psi; shear, 8,500 psi. Dimensionally stable and readily machined, Celoron fills the bill where costly metal parts fail.

ELECTRICAL INSULATION VALUE. Celoron is a non-conductor with high electrical insulation value. It makes ideal mechanical-electrical parts. Celoron couplings effectively insulate motors from driven machinery.

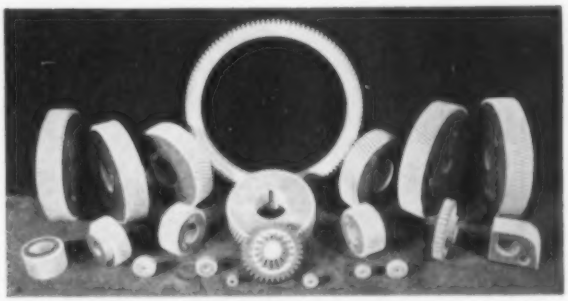
CDF FABRICATION SERVICE. Let the plastics-fabrication and molding experience of CDF save you time and money, and assure you delivery of production quantities of CDF plastics and molded parts—on time and as specified. The CDF man can help you from the very beginning. See his phone number in the Product Design File (Sweet's). Or send us your print or your problem, and we'll return samples and technical literature for your evaluation.

CDF **CONTINENTAL-DIAMOND FIBRE**

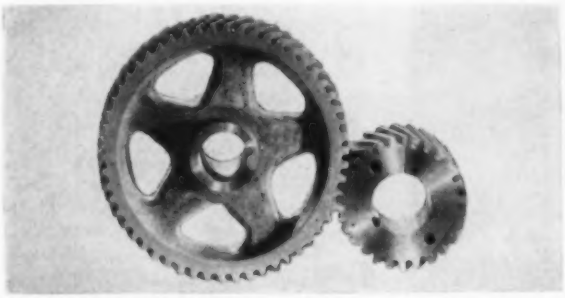
A SUBSIDIARY OF THE Bakelite COMPANY • NEWARK 40, DEL.



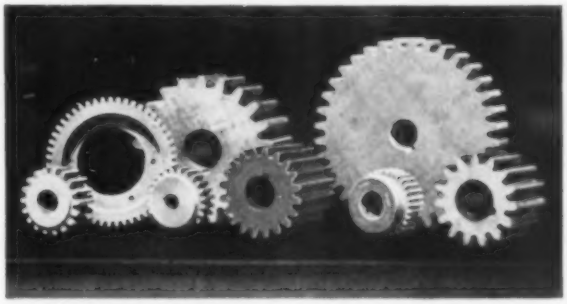
LOW-COST, EASILY-ASSEMBLED CDF Celoron flexible coupling transmits power smoothly, silently . . . insulates motor from machine . . . needs no lubrication . . . works vertically or horizontally.



PRECISELY MACHINED KEYWAYS help keep these Celoron parts silent and strong in the Ideal drawing rolls illustrated in top photograph. Note wide range of sizes and shapes.

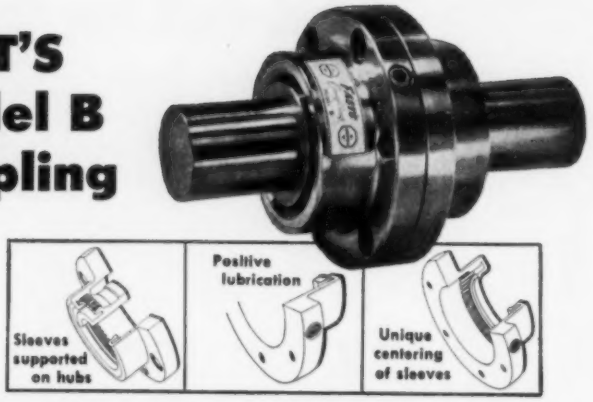


CELORON-TO-STEEL combination makes this long-wearing timing mechanism for gasoline engines. Celoron gear absorbs shock, cuts sound to a minimum, holds timing longer.



STRONG, SILENT CELORON makes both drive and driven gears. In fact, many machine applications are 100% Celoron geared for light weight, elimination of excess play, long life.

FAST'S Model B Coupling



reduces downtime and upkeep for light-to-medium drives!

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½" to 3⅛" in diameter.

The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

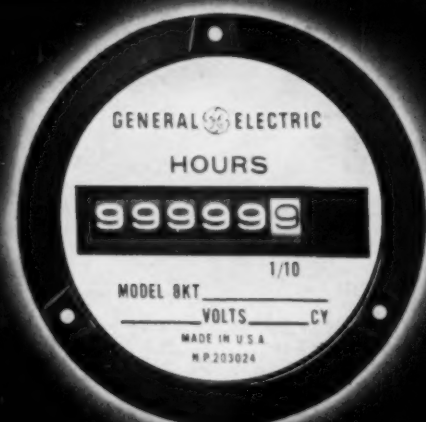
Write today for more details to KOPPERS COMPANY, INC., Fast's Coupling Dept., **7105** Scott Street, Baltimore 3, Maryland.

Engineered Products Sold with *Service*

KOPPERS

THE ORIGINAL *FAST'S Couplings*

CIRCLE 138 READER SERVICE CARD



ACTUAL SIZE

NEW LOW-COST G-E TIME METER CAN BE READ AT A GLANCE . . .

. . . because the numbers are 2 1/2 times larger than before. What's more, the new extra digit at no extra cost gives you a more exact reading. Your G-E sales engineer can give you all the facts. Ask him for bulletin GEA-6710. 584-17

GENERAL ELECTRIC

OPERATION upturn

feed arrangements and synchronization of two cylinders. All circuits are completely explained. JIC symbols are used on schematics. Logansport Machine Co, Inc, Logansport, Ind.

Circle 42, inside back cover

TIME SWITCHES—Booklet GEA-6681, 12 pp. Describes and illustrates new time switches. Includes specifications, pricing, dimensions, ordering-instructions, design features and applications. General Electric Co, Schenectady 5.

Circle 43, inside back cover

EXTRA-LOW-CARBON STAINLESS STEEL—Booklet, 8 pp. Revised edition describes two types of stainless. Gives chemical analyses and typical properties. Representative applications are illustrated. Armco Steel Corp, Middletown, Ohio.

Circle 44, inside back cover

TITANIUM CARBIDE ALLOYS—Brochure, 12 pp. Describes alloys, compositions, shapes, manufacture, characteristics, performance and applications. Supplemented by performance curves, line drawings, photos. Kennametal, Inc, Latrobe, Penna.

Circle 45, inside back cover

SMALL DIE-CAST AND MOLDED PARTS—Bulletin, 10 pp. Revised edition covers custom and standard parts. Describes and illustrates each listing and gives applications. Gries Reproducer Corp, 400 Beechwood Ave. New Rochelle, N. Y.

Circle 46, inside back cover

Letterhead Requests Only

Manufacturers who publish following literature ask that requests for copies be made on company letterheads.

IRON POWDER MELTING STOCK—Manual, 20 pp. Explains melting stock, analysis of sponge iron, carbon and carbon potential and importance of purity. Discusses sponge iron composition with special emphasis on those factors influencing use as a charge material in steel industry. Role in quality steel making is covered in detail. Hoeganaes Sponge Iron Corp, Riverton, N. J.

CUSTOM FORGINGS—Catalog F-1, 20 pp. Forging data includes everything from proper die design through forging methods, trimming, cleaning and inspection. Supplemented by photos, drawings and tables on quantity tolerances, web thickness, corner-radii tolerances, machining allowance and mismatch tolerances. Merrill Bros, Caspian St, Maspeth, N. Y.

At the Brussel's Fair IBM's Ramac presents World History in 10 languages with the help of Skinner Solenoid Valves

Visitors to the World's Fair at Brussels are given the opportunity to submit history questions to IBM's Ramac and get their answers in any one of ten languages. Millions have been fascinated by this amazing electronic data processing machine.

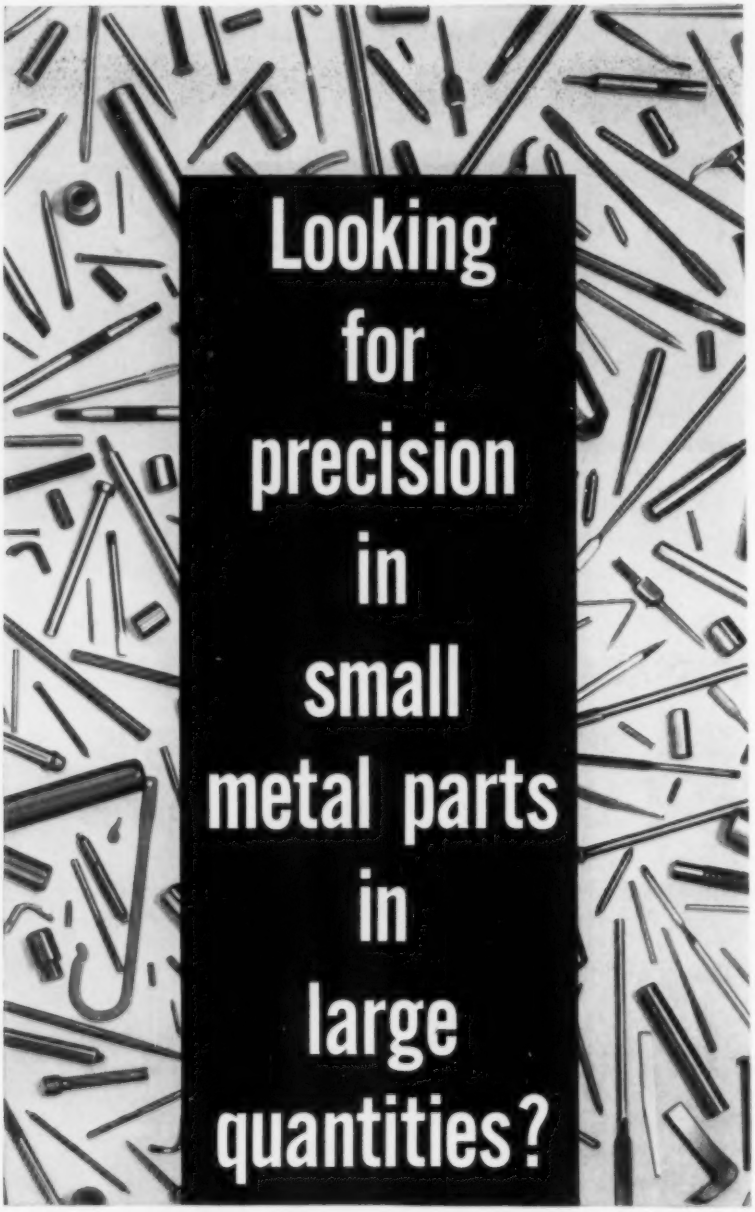
Ramac is a vast library of facts. By means of 50 rotating metal disks 5,000,000 alphamerical characters can be stored and selected at the touch of a button. The Ramac can punch 100 cards a minute, transfer data from punch cards to disks at a rate of 125 cards per minute, and print reports at speeds up to 80 lines per minute.

Three Skinner V5 three-way valves are used in the access control mechanism. One valve engages the access arm at the exact location of the disk, while the second valve disengages the arm after the read-write sequence has been completed. The third valve positions the read-write head at the precise location on the proper disk tract.

Skinner has a wide selection of solenoid valves for all types of applications. If you have a control problem, why not take it to a Skinner engineer or representative. You will find Skinner representatives listed in the Yellow Pages or write direct to Department 459.

SKINNER ELECTRIC VALVES
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE



CALL ON TORRINGTON!

Custom manufacture of small precision metal parts in large volume is the single concern of our Specialties Division. Skilled engineering and modern production facilities insure that parts are made to your most exacting standards . . . by the most economical and efficient methods for your particular job . . . on a reliable production schedule to meet your quantity requirements.

For production in quantity of high-quality precision metal parts, call our area salesman, or write direct to:

The Torrington Company, Specialties Division, 230 Field Street, Torrington, Conn.

TORRINGTON SPECIAL METAL PARTS

Makers of Torrington Needle Bearings

DESIGN ABSTRACTS

Magnetic Materials

Developments of the last six years in the theory, research, design and production of both electrically conductive metallic magnetic materials and semiconductive ceramic oxides are summarized. The various materials are compared in tables and curves.

A bibliography of 80 papers published in the US, England, Germany, France and Sweden between 1950 and 1957 is included. (Note: another article, published this year in the same magazine brings the data on this subject even further up to date.)

Abstracted from "Progress Achieved with Magnetic Materials and Their Applications," Franz Pawlek and Karl Reichel; AEG Progress, No. 4—1957; Allgemeine Elektricitatsgesellschaft, Hohenzollerndam 150, Berlin, Grunewald, Germany.

Tooling for Development

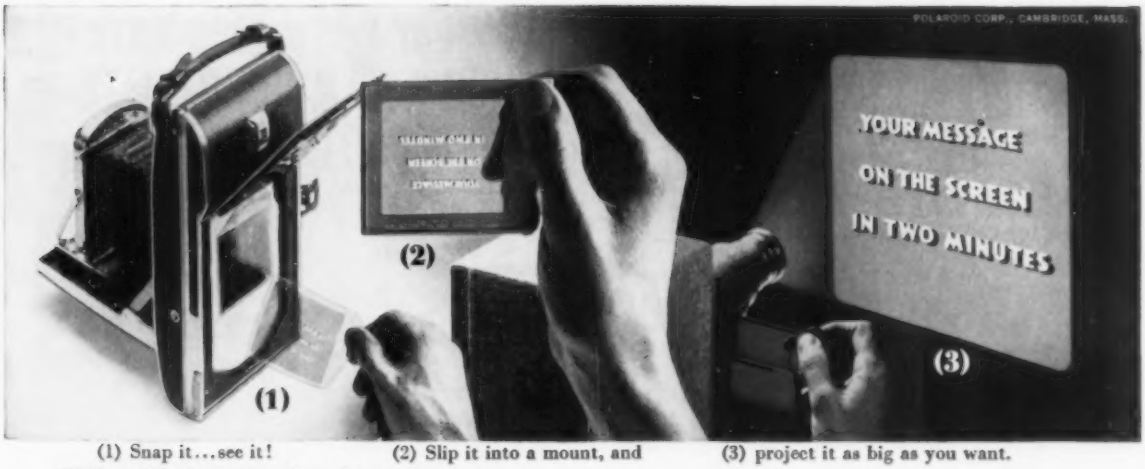
Examples from the radio-tube industry illustrate comparatively low-cost methods of producing small quantities of parts of normal production quality for use during development of new products. Simple, inexpensive tubing designed for easy modification is pictured and described.

Abstracted from "Simple Shop Practices for Short Runs," H. J. Ackerman, L. J. Caprarola, G. C. Walther, Radio Corp of America; American Machinist, Jan. 13 '58, 330 W 42nd St, New York 36.

High-temperature Lubricants

Limitations of lubricants in the 500-700 F range are described and some results of tests developed to measure such properties as viscosity, lubricity, thermal stability, oxidation and corrosion are given. Some of the chemical classes evaluated are: mineral oils, specific hydrocarbons, fluorocarbons, chlorocarbons, mixed halocarbons, polyglycol esters, phosphate esters, silicate esters, dibasic acid esters, pentaerythritol esters, complex esters, silicones.

Abstracted from "High-temperature Lubricant Studies," E. E. Klaus and M. R. Fenske, Pennsylvania State University; Lubrication Engineering, June '58, 84 E Randolph St, Chicago 1.



(1) Snap it...see it! (2) Slip it into a mount, and (3) project it as big as you want.

Polaroid Corporation Announces

QUICK, EASY WAY TO MAKE SLIDES

Polaroid Corporation has perfected a film which produces black-and-white slides right in a *regular* Polaroid® Land Camera. Just click the shutter and two minutes later you have a slide ready for projection.

The complete system includes the standard Polaroid Land Camera, the film, mounts, hardener and projector, plus a versatile Copymaker that lets you make slides from any text material, existing photographs, charts, graphs, titles or what-have-you. You have a choice of two sizes of film—2¼ x 2¼, or 3¼ x 4 (for existing "Lantern Slide" projectors). The quality of the film is remarkable—brilliant, grainless, and so sharp that projection to 12-foot screens shows no loss of detail. And it's extraordinarily fast (speaking photographically, now)—daylight speed of 1000 (ASA equivalent exposure index).

These slides cost about ⅓ as much as conventional slides. But the real saving is in the time and effort that it takes to put any picture on the screen.

Send coupon for information, case histories.

Polaroid Corporation Dept. PE-9
Cambridge 39, Massachusetts

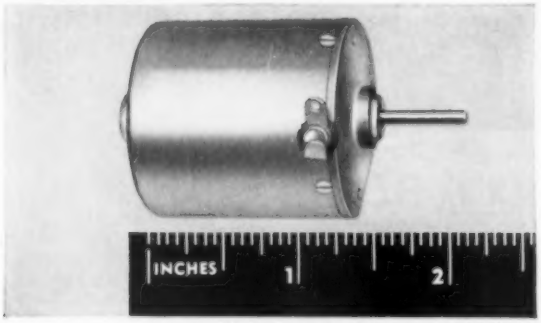
Please send me detailed information on the new Polaroid transparency system.

NAME_____
POSITION_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE____ STATE_____

CIRCLE 142 READER SERVICE CARD

THE MARK OF QUALITY
BARBER COLMAN

can you use this miniature d-c motor in your product?



Inexpensive, yet high in quality, this compact governed d-c motor is available in speeds from 1500 to 5000 rpm. Designed to operate over a voltage range of about 4 to 30 volts d-c, it is ideally suited for many applications such as: drive mechanisms in photographic equipment . . . marine navigation equipment . . . portable dictating machines . . . signal-seeking radios . . . tape players . . . and many types of portable instruments. Is this the answer to *your* design problem, too?

WRITE FOR BULLETIN F-8792 for specifications and performance data.

BARBER-COLMAN COMPANY
Dept. I, 1812 Rock Street, Rockford, Illinois

CIRCLE 143 READER SERVICE CARD

Important News FROM MEYERCORD

CHECK AND PIN THIS AD TO YOUR LETTERHEAD AND WE'LL SUPPLY THE FACTS

PLANT MAINTENANCE MARKING KIT
for Marking Water, Heating and Air Conditioning Systems

The modern, low cost solution to plant equipment identification . . . now in use by leading manufacturers and service organizations. Provides standardized identification, absolute legibility, and permanency at remarkably low cost. Kit includes 474 signs assorted over 59 operational subjects. Easily applied in seconds. Check for literature.

LUBRI-CAL MARKING KIT
Take the Guesswork Out of Your Lubrication

An important preventive maintenance program. The *Lubri-Cal Marking Kit* consists of the proper frequency of numerals, letters and instruction nameplates for identifying lubrication points and required lubricants on plant, production and operating equipment. *Lubri-Cals* are permanent, tough, oil-resistant transfers; easily adaptable to any lubrication system.

MEYERCORD DECAL MARKING METHOD
Decal product markings for "difficult surfaces"

Heat, abrasion, weather and many of the new industrial surfaces are deadly enemies of most product markings. But not to new, improved Meyercord Decal Markings—types C, G, J and H (heat resistant). One of these new markings will almost certainly solve the problem. For exact recommendations ask for new brochure.

the MEYERCORD co.
Dept. Z-318, 5323 West Lake St., Chicago 44, Illinois

CIRCLE 144 READER SERVICE CARD

Consider:

"WISCONSIN"

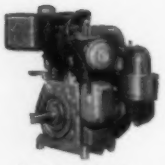
SELLING POWER

as well as

DRIVING POWER!

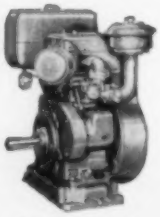
THE ENGINE SHOULD PROVIDE BOTH!

The reputability and acceptance of the equipment *you design* and *your company builds*, logically hinges upon superior performance characteristics, operating economy, low cost maintenance, long life and the ready availability of competent servicing if and when needed. All this adds up to *Selling Power!* The better the equipment, the easier it is to sell, of course.



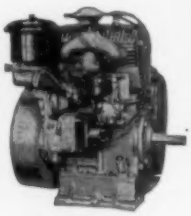
4-cycle single cyl. 3 to 7 hp.

And when it comes to original equipment *Driving Power*, each of the foregoing factors applies to Wisconsin Heavy-Duty Air-Cooled Engines. Known and accepted throughout the entire world as the top standard of engine value, the name "WISCONSIN" adds prestige and *buyers' confidence* to your own equipment. This, too, is *SELLING POWER.*



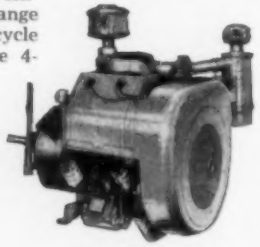
4-cycle single cyl. 7 to 12½ hp.

Wisconsin heavy-duty design and construction in all details; high torque load-holding Lugging Power and efficient AIR-COOLING at all temperatures from sub-zero to 140° F. are some of the practical considerations worth remembering.



2-cylinder models 10 to 18 hp.

Add WISCONSIN *Driving Power* and *Selling Power* to your equipment . . . for greater sales opportunities in a "hard sell" market and better satisfaction to the users of your equipment. Wisconsin Engines are supplied in a full range of sizes, 3 to 56 hp., in 4-cycle single cylinder, 2- and V-type 4-cylinder Models. *All models can be equipped with electric starting.* World-wide service available through more than 2,000 authorized service stations.



V-type 4-cyl. models 15 to 56 hp.

Complete your engine data file with a copy of Engine Bulletin S-223. Write for it today.

MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION

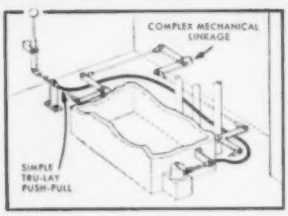
World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A8-6204½V

CIRCLE 145 READER SERVICE CARD

TRU-LAY PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY AND IMPROVE DESIGN



Push-Pull remote controls, shown here, are flexible, have but one moving part, and give a lifetime of accuracy. Mechanical linkages are complex, are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.

This Push-Pull Data File—containing 7 engineering bulletins—will show you how these flexible controls have eliminated mechanical linkages on hundreds of products. You can make *your* products more useful, easier to sell, with Push-Pull controls. Write for your Data File today.

Automotive and Aircraft Division

AMERICAN CHAIN & CABLE

ACCO

TRADE MARK

601-E Stephenson Bldg., Detroit 2
2216-E South Garfield Ave., Los Angeles 22 • 929-E Connecticut Ave., Bridgeport 2, Conn.

CIRCLE 146 READER SERVICE CARD

No. 1

IN PERFORMANCE

IN DURABILITY

IN ECONOMY

BENDIX ELECTRIC FUEL PUMP FOR EVERY INDUSTRIAL USE

In every type of industrial application, the Bendix* Electric Fuel Pump has proved itself with outstanding performance under extremely adverse conditions. In tests conducted under U. S. military supervision, it has proved itself at temperatures ranging from 114° to −76° Fahrenheit. It's easy to install and service, has a built-in pressure release, pumps more gallons per hour and positively prevents vapor lock. It will outperform any other fuel pump anywhere near its price. Write for descriptive folder and specifications. *REG. U.S. PAT. OFF.

Bendix-Elmira, N.Y.

ECLIPSE MACHINE DIVISION

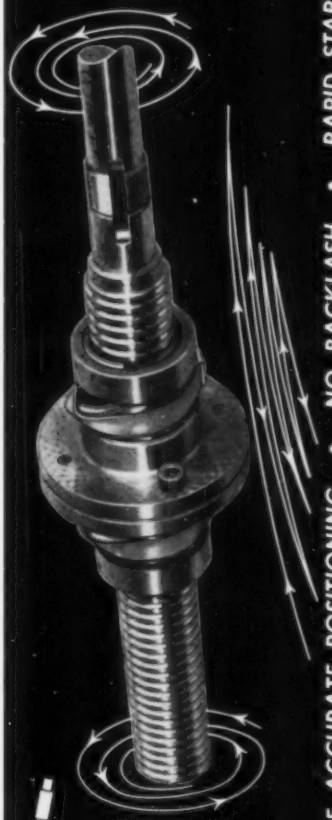
Bendix

AVIATION CORPORATION

CIRCLE 147 READER SERVICE CARD

BEAVER BALL SCREWS

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.



• EXTREME ACCURATE POSITIONING • NO BACKLASH • RAPID START • ANY DIAMETER OR TRAVEL •

Beaver Precision Products INC.
CLAWSON, MICH.

Current Reprints

Selected articles in recent issues have been reprinted in convenient form for filing. As long as the supply lasts, readers in US and Canada can secure one copy of any of these reprints without charge, by using one of the Reader Service Cards bound inside the back cover. Note that the card must be used within 60 days of publication date. If more than one copy is needed, see price list at end of this listing.

While the supply lasts, single copies of the following reprints are obtainable by using the Reader Service Card.

Engineering in Europe

Editor Tangerman's report on engineering and design uncovered during his recent European trip. Sept. 1, '58, p. 32.
Circle No. E 40

Selecting Polyphase Motors

Tables match drive-load characteristics with available motor designs in terms of torque, slip and duty cycle. Aug. 18, '58, p. 58. Circle No. E 39

Backlash in Spring Clutches

How two spring modifications can control backlash. Aug. 18, '58, p. 62.
Circle No. E 38

Swivel Joints

Guide for choosing between swivels and other flexible connections such as rubber or metal hose. Aug. 4, '58, p. 40.
Circle No. E 37

Torque-limiting Devices

Analysis of 17 new and conventional ways to prevent motor overloading and strain on equipment. Aug. 4, '58, p. 50.
Circle No. E 36

Time-displacement Records

Mechanical drum recorder offers the simplest way to get T-D records. Comparison between drum camera and its three rivals. July 21, '58, p. 78.
Circle No. E 34

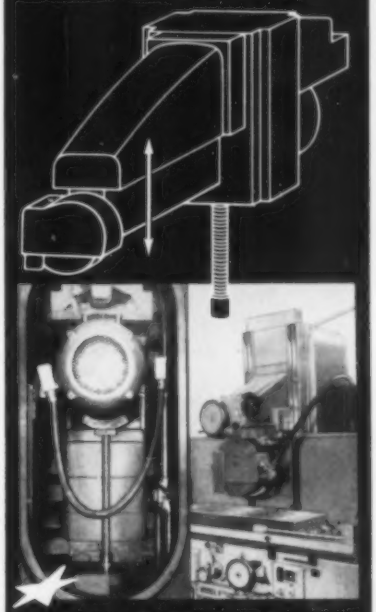
Heavy Metal

How high-density alloys may be used to solve design problems involving space and balancing. July 21, '58, p. 62.
Circle No. E 33

(Continued on page 81)

OPA ★

Gallmeyer & Livingston got it when they changed to a Beaver Ball Screw!



Optimum Positioning Accuracy with system stiffness in the head slide of their Model F surface grinder was the design objective of Gallmeyer & Livingston engineers when they changed from an acme to a ball screw — The other advantages they gained were bonuses!

Does your product require precise control of very small increments of motion? Make use of our extensive engineering and application experience. Write for free catalog.

Beaver Precision Products INC.
CLAWSON, MICH.

Custom ROTARY PROFILING

Contract rotary profiling to your drawings is a service offered by Rowbottom. Jobs are furnished complete and can be handled economically either from drawings or from machine blanks furnished by customers.

Rowbottom service in custom rotary profiling is ready with facilities to handle any quantity and to hold exactly to specified tolerances. In many cases, hardened and ground materials can be handled if required.

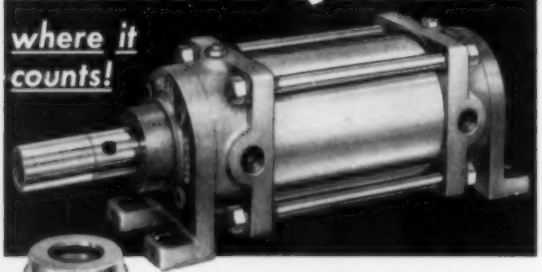
Send drawings or samples for complete quotation on prices and delivery.

The ROWBOTTOM MACHINE CO.
30 Sheffield St., Waterbury, Conn.

Rowbottom also makes Cam Milling and Cam Grinding Machines as well as Rotary Profilers. Literature on request.

CIRCLE 149 READER SERVICE CARD

MASSIVE QUALITY
where it counts!



MEEHANITE BEARING CARTRIDGE

'58

New Cylinders...

New line of Mead air cylinders, 16 sizes, mounts. Larger-than-ever ram bearing holds strict alignment, eases friction. Quick-detachable bearing cartridge to replace ram seals in minutes. Adjustable, convertible cushions, non-cushions or semi-cushions at either or both ends. Universal cylinders with interchangeable mounts (250 PSI). *Millions* of cycles prove they will take it. Get complete data from

MEAD SPECIALTIES COMPANY

4114 N. Knox Ave.
Dept. PE-98
Chicago 41, Illinois

CIRCLE 150 READER SERVICE CARD

Save time and money—

BROWNING ROLLER CHAIN DRIVES

. . . using Browning's famous interchangeable bushing system

For quality and economy, specify Browning's smooth running roller chain and precision sprockets with simplified split taper compression bushing. Browning's unbreakable bushing mounts quickly, easily—saves shop time, lowers costs. Also used in Browning couplings, paper pulleys, sheaves; standardizes plant on one-type bushing.

Send for FREE NEW CATALOG

52 pages of engineering data on Browning Roller Chain Drives. Ask for catalog CD-102.

Browning MANUFACTURING COMPANY
MAYSVILLE, KENTUCKY

CIRCLE 151 READER SERVICE CARD

Current Reprints .....continued

Stresses in Adhesive Joints

How to calculate stress concentrations of 6 basic joints. July 7, '58, p. 64.
Circle No. E 32

Designing with Cantilever Springs

Equations for 7 types show how to triple energy capacity. July 7, '58, p. 58.
Circle No. E 31

Design for Automatic Production

Product, and machine to make it are designed together for small or large quantities. June 23, '58, p. 81. Circle No. E 30

Lubricating Instrument Ball Bearings

Guide to 42 modern oils and greases. Properties and performance charts. June 9, '58, p. 66. Circle No. E 27

Sandwich-panel Adhesives

The 14 most widely specified adhesives, with comparison table. May 26, '58, p. 56.
Circle No. E 26

QUANTITY PRICES

For single shipments of any one title to one address, on order accompanied by remittance, quantity orders will be supplied at the following prices as long as the supply lasts.

Quantity	Price per Copy
5	$0.25
25	0.20
50	0.15
100	Write for quotation

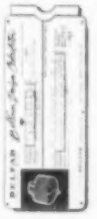
Shipments will be made promptly from stock, and prices include shipping charges. This service is offered only on request from US and Canada. Make checks payable to PRODUCT ENGINEERING, and address orders to Reader Service Dept., PRODUCT ENGINEERING, 330 West 42nd St., New York 36, N. Y.

"Economy move."

© 1958 TBC

for the first time . . .

a basic discussion of bellows design criteria including a slide calculator to provide a short cut to approximate bellows design. Made available by the The Belfab Corporation — the leader in the field of precision welded bellows. Price, one dollar.



BH

Gentlemen:
Please send a copy of the new 24-page Bellows Design Manual with Slide Calculator. Please find $1.00 enclosed.

Name..... Title.....

Company.....

Address.....

City..... State.....

THE BELFAB CORPORATION
Daytona Beach, Florida

An expert in check-out helped us check up

This test pilot of ours has checked out every new design we've had in the last two years. His business is finding answers to questions. But last week he asked *us* one.

"Why can't we rig it so I can buy U. S. Savings Bonds out of my salary, automatically?" he asked. "I want to save, but I keep forgetting about it."

We told him, of course, that we've had Payroll Savings for years. Within minutes his card was signed and he was brought into the Plan. Then we decided to check up and see how many other people on our staff had never heard about the Plan. There were quite a few.

A telephone call to our State Savings Bond Director was all we needed. He supplied us with the latest booklets, folders and forms. Then he conducted a survey straight through our company and put an application blank in the hands of every single employee.

There wasn't a bit of pressure about this information campaign, but the way our people responded was inspiring. They proved that the average American wants the fine investment security that U. S. Savings Bonds provide.

Today there are more Payroll savers than ever before in peacetime. Your State Director will be happy to help you install a Payroll Savings Plan or build enrollment in one already existing. Look him up in the phone book or write: Savings Bonds Division, U. S. Treasury Dept., Washington, D. C.

PRODUCT ENGINEERING

THE U. S. GOVERNMENT DOES NOT PAY FOR THIS ADVERTISEMENT. THE TREASURY DEPARTMENT THANKS, FOR THEIR PATRIOTISM, THE ADVERTISING COUNCIL AND THE DONOR ABOVE

INDEX OF PRODUCTS
ADVERTISED IN THIS ISSUE

After reading the advertisements classified below . . . MORE DETAILED INFORMATION about these products can be obtained by using the READER SERVICE CARD

A

Actuators
  Mechanical 13, 79
Aluminum Alloys 17
Aluminum Coated Sheet & Strip (see Steel, Coated)

B

Bearings
  Ball 15, 30, 59
  Needle 59
  Roller 1, 15, 30, 59
Bellows 47, 81
Belts, V 52
Blowers 68
Brass 57
Brushes ..... 4th Cover
Bushings 80

C

Carbon ..... 4th Cover
Chains
  Roller 80
Chemical Treatments 69
Coatings 69
Controls
  Electrical 54
  Mechanical 78
  Pneumatic 70
Copper & Copper Alloys 57
Couplings
  Mechanical 74
Cylinders
  Hydraulic 62, 72
  Pneumatic 66, 70, 72, 80

D

Decalcomanias 77
Die Castings 86
Drives
  Adjustable Speed 4
  Variable Speed ..... 2nd Cover

E

Engineering Services (see also Production Services) 76
Engines 78
Extrusions
  Metallic 10, 17

F

Fabricated Plastics (see Plastics, Fabricated)
Fabricated Steel (see Weldments)

G

Gears ..... 2nd Cover, 6, 71
Graphite ..... 4th Cover

H

Heating Units 65

I

Instruments
  Electrical 74

L

Lubricants 69

M

Moldings
  Plastics (see Plastic Parts)
  Rubber (see Rubber Parts)
Molybdenum Alloys 27
Motors, A-C
  Fractional 11, 28
  Integral 11
  Sub-Fractional 11, 28, 66, 68
Motors, D-C
  Fractional 11, 28, 77
  Integral 11
  Sub-Fractional 11, 28, 68, 77

N

Name Plates 77

P

Photographic Equipment
  Film 63, 77
Plastic Parts 18, 60
Plastics 18, 60, 73
Plastics Fabricated 73
Production Services (see also Engineering Services) 76, 80
Pumps
  Liquid 68, 78

R

Reproduction Equipment 63
Reproduction Supplies 63
Retaining Rings 67
Rings 61
Rod Ends 30
Rubber Parts ..... 3rd Cover
Rust Proofing 69

S

Screws 16
Seals ..... 3rd Cover
Sheaves 80
Speed Increasers & Reducers ..... 2nd Cover, 6
Splines 13
Sprockets 80
Steel
  Alloy 8-9, 14
  Coated 2, 50
  Stainless 8-9, 10
  Tool 10, 14

T

Tubing
  Seamless 12

V

Valves
  Air 66, 70, 75
  Control 66
  Hydraulic 75
  Solenoid 75

W

Weldments 61
Wire 64
Wire Cloth 64

Z

Zinc Coated Sheets 2, 50
Zinc Coated Strips 2

THE CITY THAT DIDN'T EXIST A MONTH AGO

Every 30 days the U. S. adds as many new Americans as live in Norfolk, Va.—creating brand-new wants and needs which must be satisfied.

What does this mean to you? It means greater opportunities than ever before—in all fields. Home construction is expected to double by 1975. Power companies plan to increase output 250% in the next 20 years to provide the power for scores of new labor-saving devices. Clothing suppliers predict a one-third increase in 7 years.

With 11,000 new citizen-consumers born every day, there's a new wave of opportunity coming.

7 BIG REASONS FOR CONFIDENCE IN AMERICA'S FUTURE

1. **More people** . . . Four million babies yearly. U. S. population has *doubled* in last 50 years! And our prosperity curve has always followed our population curve.
2. **More jobs** . . . Though employment in some areas has fallen off, there are *15 million* more jobs than in 1939—and there will be *22 million more* in 1975 than today.
3. **More income** . . . Family income after taxes is at an all-time high of $5300—is expected to pass $7000 by 1975.
4. **More production** . . . U. S. production *doubles* every 20 years. We will require millions more people to make, sell and distribute our products.
5. **More savings** . . . Individual savings are at highest level ever—*$340 billion*—a record amount available for spending.
6. **More research** . . . *$10 billion* spent each year will pay off in more jobs, better living, whole new industries.
7. **More needs** . . . In the next few years we will need *$500 billion* worth of schools, highways, homes, durable equipment. Meeting these needs will create new opportunities for everyone.

Add them up and you have the makings of another big upswing. Wise planners, builders and buyers will act *now* to get ready for it.

FREE! Send for this new 24-page illustrated booklet, "Your Great Future in a Growing America." Every American should know these facts. Drop a card today to: ADVERTISING COUNCIL, Box 10, Midtown Station, New York 18, N. Y.

(This space contributed as a public service by this magazine.)

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibilities for errors or omissions

A

Allegheny Ludlum Steel Corp. 10
Allen Mfg. Co. 16
Aluminum Co. of America. 17
American Welding & Mfg. Co. 61
Armco Steel Corp. 2
Automotive & Aircraft Div., American Chain & Cable Co. 78

B

Barber-Colman Co. 77
Beaver Precision Products, Inc. 79
Belfab Corp., The 81
Bendix Aviation Corp., Eclipse Machine Div. 78
Bodine Electric Co. 28
Bridgeport Brass Co. 57
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co. 47
Browning Mfg. Co. 80

C

Cleveland Worm & Gear Co. ....2nd Cover
Climax Molybdenum Co. 27
Continental Diamond Fibre Co., Subs., Budd Co. 73
Cutler-Hammer, Inc. 4

D

De Laval Steam Turbine Co. 6
Dow Chemical Co. 18

G

General Electric Co., Apparatus Dept. 74
General Industries Co. 66

H

Hanna Engineering Works. 62
Heim Co. 30
Heinze Electric Co. 68
Hyatt Bearings Div., General Motors Corp. 1

K

Kaydon Engineering Corp. 59
Koppers Co., Inc., Metal Products Div. 74

M

Madison-Kipp Corp. 86
Mead Specialties Co. 80
Meyercord Co., Name Plate Div. 77
Minneapolis-Honeywell Regulator Co. 54
Minnesota Rubber Co. .....3rd Cover
Modern Industrial Plastics, Inc. 60

N

National-Standard Co. 64
National Tube Div., U. S. Steel Corp. . 12

O

Ortman-Miller Machine Co. 72

P

Parker Rust Proof Co. 69
Perkins Machine & Gear Co. 71
Polaroid Corp. 77

R

Recordak Corp., Subs., Eastman Kodak Co. 63
Robbins & Myers, Inc. 11
Rowbottom Machine Co. 80

S

SKF Industries, Inc. 15
Saginaw Steering Gear Div., General Motors Corp. 13
Schrader's Son A., Div., Scovill Mfg. Co., Inc. 70
Skinner Electric Valve Div., Skinner Chuck Co. 75

T

Timken Roller Bearing Co., Steel & Tubes Div. 14
Torrington Co., Specialties Div. 76

U

U. S. Graphite Co., Div. of the Wickes Corp. .....4th Cover
U. S. Rubber Co., Mechanical Goods Div. 52
U. S. Steel Corp. 8-9

V

Viking Pump Co. 68

W

Waldes Kohinoor, Inc. 67
Watlow Electric Mfg. Co. 65
Weirton Steel Co., Div., National Steel Corp. 50
Westinghouse Air Brake Co., Industrial Products Div. 66
Wisconsin Motor Corp. 78

PRODUCT ENGINEERING ADVERTISING SALES STAFF

Atlanta 3 . . . M. H. Miller, 1301 Rhodes-Haverty Bldg., Jackson 3-6951

Boston 16 . . . M. A. Williamson, Jr., 350 Park Square Bldg., Hubbard 2-7160

Chicago 11 . . . Mid-Western Adv. Sales Manager, A. E. Meanor; R. W. Bruley, L. Anderson, 520 N. Michigan Ave., Mohawk 4-5800

Cleveland 13 . . . A. F. Tischer, 1164 Illuminating Bldg., 55 Public Square, Superior 1-7000

Dallas 1 . . . E. E. Schirmer, 901 Vaughn Bldg., 1712 Commerce St., Riverside 7-5117

Denver 2 . . . John W. Patten, 1740 Broadway, Mile High Center, Alpine 5-2981

Detroit 26 . . . P. B. Robinson, 856 Penobscot Bldg., Woodward 2-1793

Los Angeles 17 . . . Robert Obenour, 1125 West 6th St., Madison 6-9351

New York 36 . . . B. K. Adams, J. C. Taney, R. G. Wallace, 500 Fifth Ave., Oxford 5-5959

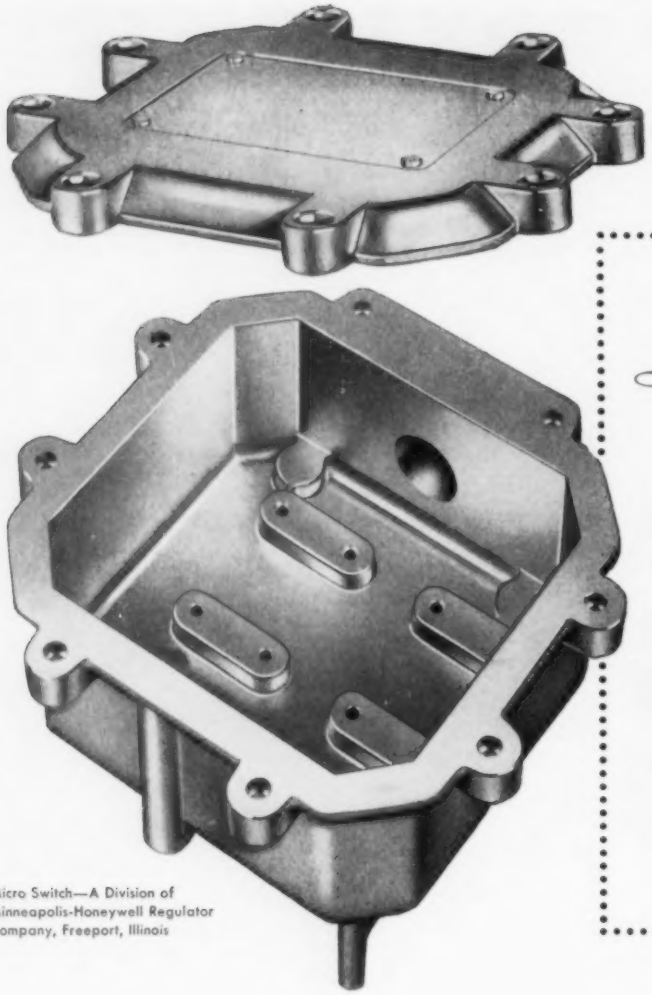
Philadelphia 3 . . . D. G. Jones, K. S. Wiladson, 6 Penn Center Plaza, Locust 8-4330

Pittsburgh 22 . . . C. F. Leveroni, 1111 Oliver Bldg., Atlantic 1-4707

St. Louis 8 . . . R. W. Bruley, 3615 Olive St., Continental Bldg., Jefferson 5-4867

San Francisco 4 . . . W. C. Woolston, 68 Post St., Douglas 2-4600

Index to Advertisers appears on P 85
Products Index appears on P 83



*Micro Switch—A Division of Minneapolis-Honeywell Regulator Company, Freeport, Illinois

Lifetime Quality

with MADISON-KIPP zinc and aluminum die castings

The earmarks of lifetime quality are never elusive. They are there to see in dis-assembled, unpainted components. They are there to see in break-down tests.

The Kipp die cast body and cover of the *Micro Switch instrument here illustrated are of lifetime quality not only to encase and protect functional parts, but also to provide a rigid frame, ample bearing bosses, stable dimensions, and other last word engineering features.

The attentive mechanics at Madison-Kipp invite you to clip this ad as a reminder to contact them for close cooperation on the momentous details of design when you next have die casting requirements.

kipp

MADISON-KIPP CORPORATION
206 Waubesa Street • Madison 10, Wis., U.S.A.

Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

Get Complete Information Promptly... Use These Convenient, Time-Saving Cards

To be fully informed of all the significant new developments in your field is a vital and never-ending task.

We make this big job easier for you. By just using one of the attached postcards you can secure:

- ...reprints of articles you'll use most often for a concise, ready source of material
- ...complete data on components and materials of utmost importance to you
- ...new catalogs and bulletins (those summarized in Product Engineering have first been carefully screened by our large staff of engineer-editors)
- ...more details on advertised products
- ...subscription to the new weekly PRODUCT ENGINEERING

Please turn the page and make your selections. We do the rest.

HOW TO USE CARDS

Every Advertisement, New Product and Bulletin is numbered. For more information, circle key number that corresponds to number at the bottom of Advertisement, New Product or Bulletin.

For single copy of Free reprints offered, circle E number that corresponds to reprint requesting (listing inside).

To start your subscription to PRODUCT ENGINEERING, fill in card marked "subscription".

CAUTION: Do not forget to print your name, title, address and company name before mailing.

Issue of September 1, 1958
Product Engineering
Card Expires 11/1/58

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

6¢ Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING—
330 WEST 42nd STREET
NEW YORK 36, N. Y.

Issue of September 1, 1958
Product Engineering
Card Expires 11/1/58

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

6¢ Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING—
330 WEST 42nd STREET
NEW YORK 36, N. Y.

Use these convenient cards for a

Copies of Editorial Reprints Offered

E26. Sandwich-panel Adhesives
The 14 most-specified adhesives compared. (5/26/58)

E27. Lubricating Ball Bearings
42 oils and greases for instrument bearings. (6/9/58)

E30. Design for Automatic Production
For small as well as large quantities. (6/23/58)

E31. Designing with Cantilever Springs
Equations for 7 types shows how to triple energy capacity. (7/7/58)

E32. Stresses in Adhesive Joints
How to calculate stress concentrations of 6 basic joints. (7/7/58)

E33. Heavy Metal
How high-densisty alloys may be used to solve design problems involving space and balancing. July 21, '58.

E34. Time-displacement Records
Mechanical drum recorder offers the simplest way to get T-D records. July 21, '58.

E35. PE Editorial Index—Jan.-June 1958

E36. Torque-limiting Devices
Analysis of 17 new and conventional ways to prevent motor overloading and strain on equipment. (8/4/58)

E37. Swivel Joints
Guide for choosing between swivels and other exible connections such as rubber or metal hose. (8/4/58)

E38. Backlash in Spring Clutches
How spring modifications can control backlash. (8/18/58)

E39. Selecting Polyphase Motors
Tables match drive-load characteristics with available motor designs in terms of torque, slip and duty cycle. (8/18/58)

E40. Engineering in Europe
Editor Tangerman's report on engineering and design uncovered during his recent European trip. (9/1/58)

Description of New

GENERAL ENGINEERING

28—Drafting Machine

NON-METALLIC MATERIALS, FINISHES

3—One-coat Organic Finish

4—Powder Vinyl Coatings

28—Plastic Metal Kit

POWER TRANSMISSION

10—7 Million: 1 Reduction

15—Two-pinion Differential

18—Magnet-set Clutch-brake

E26	E27	E30	E31	E32	E33	E34	E35	E36	E37	E38	E39	E40
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117
118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134
135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185
186	187	188	189	190	191	192	193	194	195	196	197					
198	199	200	201	202	203	204	205	206	207	208	209					
210	211	212	213	214	215	216	217	218	219	220	221					
222	223	224	225	226	227	228	229	230	231	232	233					
234	235	236	237	238	239	240	241	242	243	244	245					
246	247	248	249	250	251	252	253	254	255	256	257					
258	259	260	261	262	263	264	265	266	267	268	269					
270	271	272	273	274	275	276	277	278	279	280	281					

INSIDE FRONT COVER INSIDE BACK COVER BACK COVER

*Multiple product ads.

Key No. Specific Product

_____ _____

_____ _____

_____ _____

***WHERE ADVERTISEMENTS LIST MORE THAN ONE PRODUCT, INDICATE IN BOX ON CARD THE KEY NUMBER AND SPECIFIC PRODUCTS IN WHICH YOU ARE INTERESTED. ALSO, A FEW ADS CANNOT BE KEYED. WHEN THIS OCCURS PLEASE WRITE ADVERTISER'S NAME ON LINE AT BOTTOM OF CARD.**

Please print or type

NAME .....POSITION .....

COMPANY .....

BUS. ADDRESS .....CITY .....STATE .....

E26	E27	E30	E31	E32	E33	E34	E35	E36	E37	E38	E39	E40
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117
118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134
135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185
186	187	188	189	190	191	192	193	194	195	196	197					
198	199	200	201	202	203	204	205	206	207	208	209					
210	211	212	213	214	215	216	217	218	219	220	221					
222	223	224	225	226	227	228	229	230	231	232	233					
234	235	236	237	238	239	240	241	242	243	244	245					
246	247	248	249	250	251	252	253	254	255	256	257					
258	259	260	261	262	263	264	265	266	267	268	269					
270	271	272	273	274	275	276	277	278	279	280	281					

INSIDE FRONT COVER INSIDE BACK COVER BACK COVER

*Multiple product ads.

Key No. Specific Product

_____ _____

_____ _____

_____ _____

Please print or type

NAME .....POSITION .....

COMPANY .....

BUS. ADDRESS .....CITY .....STATE .....

New Catalogs and

GENERAL ENGINEERING

34—Speed-measuring Instruments, 20 pp, James G Biddle Co.

METALS AND ALLOYS

33—Low-alloy Steel, 20 pp, Kaiser Steel Corp, Engineering Sales Dept.

44—Extra-low-carbon Stainless Steel, 8 pp, Armco Steel Corp.

45—Titanium Carbide Alloys, 12 pp, Kennametal, Inc.

NON-METALLIC MATERIALS, FINISHES

31—Epoxy Glass Laminates, 21 pp, Mica Corp.

FABRICATION PROCESSS AND PRODUCTION

32—Vacuum Metallizing Coatings, 16 pp, Bee Chemical Co.

MECHANICAL PARTS

36—Finished Bore sprockets, 4 pp, Acme Chain Corp.

39—Transmission Belting, 4 pp, Coriamid, Inc.

46—Small Die-cast and Molded Parts, 10 pp, Gries Reproducer Corp.

wealth of vital information . . .

Components and Materials Appearing on Pages 55-71

MECHANICAL PARTS

16—Micronic In-tank Filter
21—Thin-section Ball Bearings

FASTENING AND JOINING

6—Tamperproof Cap Nuts
11—Cryogenic Swivel Joint

MOTORS, ENGINES AND CONTROLS

1—Motor Operates Underwater
2—Regulator Programs Pressure
5—Wiring Redesign In Motors
8—Lightweight Torque Motor
9—Predetermining Counter
19—Adjustable Cycling Timers
1 —Weatherproof AC Motor
20—Liquid-level Switch

ELECTRICAL, ELECTRONIC COMPONENTS

7—Redesigned Terminal Block
12—Motor Starting Relays
24—Miniature Relay
22—Subminiature Switch
23—Edgewise Meter
25—Alternate-action Actuator

HYDRAULIC, PNEUMATIC EQUIPMENT

14—Self-closing Relief Valves
13—Purge Valves
27—Flow Rate Indicator
26—Pneumatic Release Valve

All your requests can be made on a single card. Please save extra cards for your associates who may read this copy

E26	E27	E30	E31	E32	E33	E34	E35	E36	E37	E38	E39	E40
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117
118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134
135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185
186	187	188	189	190	191	192	193	194	195	196	197					
198	199	200	201	202	203	204	205	206	207	208	209					
210	211	212	213	214	215	216	217	218	219	220	221					
222	223	224	225	226	227	228	229	230	231	232	233					
234	235	236	237	238	239	240	241	242	243	244	245					
246	247	248	249	250	251	252	253	254	255	256	257					
258	259	260	261	262	263	264	265	266	267	268	269					
270	271	272	273	274	275	276	277	278	279	280	281					

INSIDE FRONT COVER INSIDE BACK COVER BACK COVER

*Multiple product ads.

Key No.	Specific Product

Bulletins (p. 72-74)

FASTENING AND JOINING

30—Fastener Application, 16 pp, Russell, Burdsall & Ward Bolt & Nut Co.
35—Self-locking Set Screws, chart, Set Screw & Mfg Co.
37—Continuous-sleeve Flexible Couplings, 4 pp, Zurn Industries.
41—Adapters for Hose Fittings, 12 pp, Parker-Hannifin Corp.

MOTORS, ENGINES AND CONTROLS

40—1/20 to 200 Hp Motors, 4 pp, Marathon Electric Mfg Corp.

ELECTRICAL, ELECTRONIC COMPONENTS

43—Time Switches, 12 pp, General Electric Co.

HYDRAULIC, PNEUMATIC EQUIPMENT

38—Stainless Steel Flexible Hose, 4 pp, Allied Metal Hose Co.
42—Fluid Power Circuits, 28 pp, Logansport Machine Co, Inc.

Please print or type

NAME .....POSITION .....

COMPANY .....

BUS. ADDRESS .....CITY .....STATE .....

SUBSCRIPTION CARD

OK Enter my subscription to PRODUCT ENGINEERING for 1 year @ $5.00 (52 weekly issues plus Design Digest issue)

Subject to cancellation at any time with request for refund on unexpired term.

☐ Payment enclosed ☐ Bill me ☐ Check here for 2 yrs. at $8.00

NAME .....POSITION .....

ADDRESS (Home).....COMPANY .....

CITY .....ZONE .....STATE .....

CO. NAME .....PRODUCT MFRD.....

- Reprints of editorial features
- More data on materials and components
- Copies of new catalogs and bulletins
- More information on advertised products
- Subscription to new weekly PRODUCT ENGINEERING

Get Complete Information Promptly... Use These Convenient, Time-Saving Cards

Issue of September 1, 1958
Product Engineering
Card Expires 11/1/58

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

6¢ Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING—
330 WEST 42nd STREET
NEW YORK 36, N. Y.

Issue of September 1, 1958
Product Engineering
Card Expires 11/1/58

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

6¢ Postage Will Be Paid By Reader Service Department

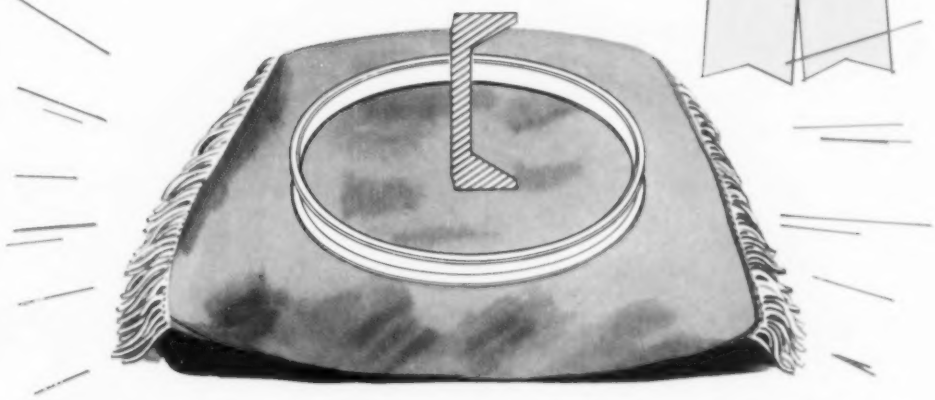
PRODUCT ENGINEERING—
330 WEST 42nd STREET
NEW YORK 36, N. Y.

SUBSCRIPTION

An Opportunity To Get More Information Quickly, Conveniently

Presenting the

Engineer Approved



KAPSEAL®

by MINNESOTA RUBBER Co.

The KAPSEAL® is a Teflon® boot which is used in combination with a standard O-Ring. It comes in two styles, Kin for applications in which the sealing surface is the ID of the seal, and Kex where the OD is the sealing surface.

The KAPSEAL® was originally designed and perfected by Bendix Aviation Corporation, Pacific Division, and was patented by them. They selected Minnesota Rubber Company to be the sole manufacturer under an exclusive license.

A seal of this nature was needed for applications which involved long periods of time on stand-by or in storage, as well as applications requiring continuous operation. The KAPSEAL® eliminated the welding problem commonly experienced with elastomeric seals under these conditions. It also eliminated the high breakout force needed when metallic seals were used.

Minnesota Rubber engineers have tested the KAPSEAL® under many different conditions and results have been nothing short of spectacular. In a low pressure, pneumatic cycling application, both wet and dry, the KAPSEAL® lasted over 4 million cycles before the test was stopped. In a hydraulic control valve 2 million cycles were completed before the test was stopped. These are just two of the many applications in which the KAPSEAL® will give outstanding performance.

Some other applications where the KAPSEAL® will give superior sealing include:

1. High frequency, low amplitude, high response mechanisms.
2. Mechanisms which must operate the first time with minimum breakout friction.
3. Standby machinery which must operate freely after prolonged periods of inactivity.
4. Long-life equipment where dismantling for seal replacement is exceptionally costly.
5. Throw-away components where savings due to long-life low friction seals make a "buttoned-up" design possible.
6. Finger-tip control and solenoid operated mechanisms.
7. Long run continuously operating mechanisms.

WHERE LIFE OR FRICTION IS A PROBLEM, THE KAPSEAL IS THE ANSWER

FOR MORE INFORMATION WRITE:

MINNESOTA RUBBER

3630 WOODDALE AVENUE
Minneapolis 16, Minnesota
Department No. 217

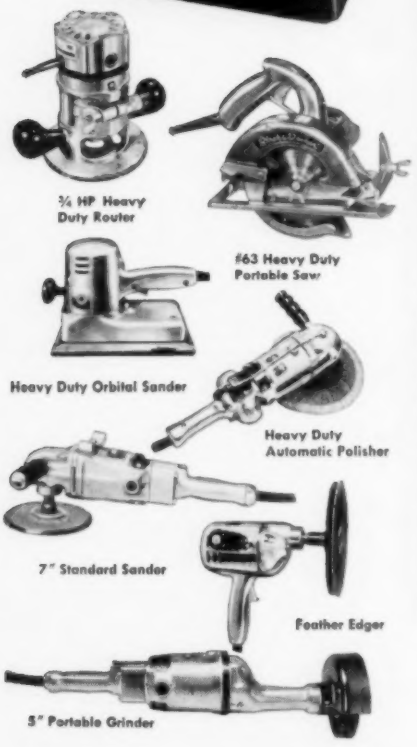
KAPSEAL® is a trademark of Minnesota Rubber Company

TEFLON® is a trademark of the Dupont Company

KAPSEAL Patented by Bendix Aviation Corp., No. RE. 24440

BRUSHES

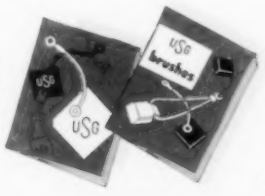
help give BLACK & DECKER INDUSTRIAL TOOLS power, long life, maintenance-free service



For more than forty years Black & Decker electric tools have been recognized by users as the most dependable and adequate tools of their kind. This reputation has been earned through rigid quality control, intensive research, testing and design engineering. To help make these tools first in performance and quality the world over, Black & Decker specify USG motor brushes. (Some of the industrial electric tool applications are pictured here.)

United States Graphite Company (USG) brushes are giving excellent service not only in Black & Decker products, but also in hundreds of installations, large and small, throughout industry. Because the brushes in any electric powered unit are so vital to the long life, power and maintenance-free service of that unit, it pays to specify USG brushes of carbon, carbon-graphite, electro-graphite, graphite, metal graphite or silver graphite.

Write for catalog B-56 and the USG grade list. Most of the information necessary to design engineers is contained in these two books.



B-246-1

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 1, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES